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EFFECT OF MASTICATORY FORCES TRANSMITTED BY DENTAL IMPLANTS ON THE MANDIBULAR BONE OF PATIENTS WITH TYPE 2 DIABETES MELLITUS

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Abstract

Background and Aims: *Diabetes mellitus is considered to be one of the most important diseases of our society, affecting a considerable proportion of the adult population. Currently, dental implant treatment of diabetic patients is controversial, the main controversy being related to changes that occur in the jaw bones of the diabetic patient and the ensuing side effects. This preliminary study aims to evaluate the response of mandibular bone to masticatory forces transmitted by dental implants in diabetic patients.* ***Material and Method:*** *11 dental implants placed in the mandible were selected, and mandibular bone resorption as a result of masticatory forces transmitted by them was evaluated.* ***Results:*** *The mean bone resorption rates were the following: 2.72% at the time of dental implant exposure, 10% at 3 months from dental implant exposure, and 13.63% at 6 months from exposure.* ***Conclusions:*** *No significant changes in mandibular bone response to the action of dental implants were found in diabetic patients compared to standard response reported in non-diabetic patients.*

key words: *masticatory forces, diabetes mellitus, dental implants.*

Background and Aims

Diabetes mellitus is a chronic metabolic disorder that affects a considerable proportion of the world's adult population. In USA, the number of patients with diabetes mellitus (both type 1 and type 2) is estimated at 25.6 million, which is more than 11% of the adult population, while the number of newly diagnosed patients is continuously increasing [1]. It is estimated that by 2050, about 30% of the USA population will suffer from diabetes mellitus, particularly type 2 [2].

Currently, teeth lost by patients following dental extractions or secondarily to periodontal disease, as well as tooth and jaw functions are optimally restored using dental implants [3]. For a long time, diabetes was considered to be a contraindication to dental implant therapy, and continues to be one of the most frequent reasons

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pleading against the use of dental implants [4]. Given that a number of studies evidence significant changes of bone structure response in patients with type 2 diabetes mellitus (T2D) [5,6], the importance of knowing the interaction of dental implants with the recipient area and tooth and jaw function is obvious.

The forces exerted during mastication on tooth support are influenced by a series of factors: occlusion, antagonist teeth, muscle tone, temporomandibular joint status [7,8]. This masticatory force in the healthy individual is received by the tooth support and transmitted to the alveolar bone, with an influence on craniofacial biomechanics [9]. The response of alveolar bone to this masticatory force is different depending on the position of the tooth in the dental arch, as it is known that in the anterior area masticatory forces are lower than in the posterior area of the mandible [10]. In the case in which dental implants are placed in the alveolar processes, these have the role to replace natural teeth and implicitly, to receive masticatory forces. Bone response to the action of masticatory forces transmitted by dental implants has been studied by a number of authors [11,12], but without taking into account associated systemic disorders that can alter bone structure such as diabetes mellitus.

The aim of this preliminary study was to evaluate mandibular bone response to masticatory forces transmitted by dental implants in patients with T2D.

Material and Method

This was a prospective study, performed in 3 patients undergoing oral rehabilitation with dental implantation. Patient selection criteria were the following: adult age, presence of T2D, absence of other disorders or systemic treatments susceptible to change bone metabolism except for T2D, mandibular edentation requiring dental implant placement, absence of pathological lesions in the mandibular bone, the patient's informed consent to the treatment plan and inclusion in the study, osseointegration and functional loading of the dental implants.

For each patient, the following variables were recorded: 1) general data such as age, sex, background; 2) characteristics of T2D: disease duration, complications, glycated hemoglobin (HbA1c) values; 3) data on each implant placed: position in the dental arch, implant length, bone resorption at the time of implant exposure and 3 and 6 months after functional loading.

For each implant, bone attachment was assessed at the reference time, the time of implant placement, at the time of implant exposure, and 3 and 6 months after functional loading. Bone attachment was assessed by panoramic imaging at a 1/1 scale. The reference length was measured on radiographs and for each implant, bone attachment was measured at the previously mentioned time points. Subsequently, bone resorption was quantified numerically in millimeters and as percentage of the initial value. All implants included in the study were placed in the posterior mandibular region and had a length of 10 mm, which was the reference value. HbA1c values were communicated by the diabetologist following periodic medical check-up at a 3 month interval. For each patient, the mean HbA1c value for the monitored time period was calculated and this was considered the reference value.

The study included 11 dental implants. For data collection and contingency tables, the Microsoft Excel software was used.

Results

The age of the patients included in the study was 61, 63 and, respectively, 58 years. All patients were of male sex. Two patients were from an urban environment, while one patient was from a rural environment.

The mean HbA1c value was 7.63% (range between 6.9% and 8.2%). The mean duration of diabetes from diagnosis to dental implant placement was 7.66 years (range between 4 years and 12 years). Antidiabetic treatment consisted of oral antidiabetics in the case of two patients and insulin therapy in the case of one patient. Antidiabetic treatment for one patient was represented by Metformin 1000 mg twice a day, Glimepiride 4mg twice a day, Dapagliflosin 10 mg once a day. The second patient treated with oral antidiabetics was receiving Metformin 250 mg twice a day and Gliclazide 60 mg single dose treatment. In the case of one patient treatment was represented by basal insulin Glarigine 40 UI once a day in the evening.

In all patients included in the study, dental implants were placed in the posterior mandibular region. The number of implants varied between a minimum of 2 implants and a maximum of 5 implants, as for the case presented in Figure 1. All implants had a length of 10 mm and were placed according to the instructions of the manufacturer. The length of 10 mm was considered the reference length.

Figure 1. *Panoramic radiograph evidencing the dental implants immediately after their placement, 1:1 scale.*

Exposure of dental implants was performed 6 months after their placement, when their stability was evaluated by applying a 20 Nm torque force using a dynamometric key. All implants had a favorable evolution and showed no mobility when the force was applied to assess their stability. At this time point, the first radiographic evaluation and measurement of the bone attachment were also performed. At 6 months from dental implant placement, a mean peri-implant bone height of 9.72 mm was measured. Subsequently, radiographic evaluation 3 months after the prosthetic loading of implants (this is 9 months after their placement) evidenced a mean peri-implant height of 9 mm.

The last measurement was performed 6 months after prosthetic loading (this is 12 months after implant placement) as shown in Figure 2. This measurement showed a mean peri-implant height of 8.63 mm.

Figure 2. *Panoramic radiograph evidencing the dental implants 12 months after their placement, 1:1 scale.*

Table 1 shows the nominal values of bone attachment height for each implant analyzed in the study.

Table 1. Nominal values of bone attachment height for the implants included in the study.

Position in the dental arch	**Reference value (mm)**	**Bone attachment (mm)**		
		At the time of exposure	**3 months after exposure**	**6 months after exposure**
4.5.	10	10	9.5	9
4.6.	10	10	9	9
4.7.	10	10	9	9
3.6.	10	10	9	8
3.7.	10	10	9.5	9.5
4.6.	10	10	9	8.5
4.7.	10	8	7.5	7
3.4.	10	10	9	9
3.7.	10	9	8.5	8
4.4.	10	10	9.5	9
3.4.	10	10	9.5	9

The bone resorption rate was expressed as percentage for the time points included in the calculation and as nominal values for a 12-month interval after dental implant placement. The mean bone resorption rates were as follows: 2.72% at the time of dental implant exposure, 10% at 3 months from dental implant exposure, and 13.63% at 6 months from exposure. The bone resorption rate for each implant is shown in Table 2.

Table 2. The bone resorption rate around dental implants.

Position in the dental arch	**Bone resorption rate (%)**		
	Time of exposure	**At 3 months**	**At 6 months**
4.5.	0	5	10
4.6.	0	10	10
4.7.	0	10	10
3.6.	0	10	20
3.7.	0	5	5
4.6.	0	10	15
4.7.	20	25	30
3.4.	0	10	10
3.7.	10	15	20
4.4.	0	5	10
3.4.	0	5	10

During the monitoring period, the maximum HbA1c value was higher than 8% in the case of a patient, and less than 7.5% in the case of the other two patients, according to their reports.

Discussions

Dental implant treatment in patients with various systemic disorders is an issue of real interest in the literature [1,13]. Studies carried out so far have mainly focused on the clinical evaluation of dental implant osseointegration in diabetic patients, with contradictory results, reporting failure rates of dental implant osseointegration between 0 and 31% [1]. It seems that implants placed in diabetic patients integrate better in the mandible [13], possibly due to its higher bone density, which confers a higher mechanical resistance. In this study, all mandibular implants were placed with a maximum success rate of osseointegration. However, this was not the aim of our study but to evaluate the bone response to masticatory forces transmitted by dental implants in diabetic patients. This is why patients without dental implant osseointegration could not be included in the study.

The first factor that should be considered when evaluating dental implants is bone stability when prosthetic loading is intended. In the case of the patients included in this study, no evidence of dental implant instability was found, which is why prosthetic loading was performed. It is not surprising that bone healing during the osseointegration of dental implants was adequate, particularly considering that the patients included in our study had relatively good glycemic control, which is essential for adequate peri-implant healing [14]. The literature recommends a HbA1c below 8% for an optimal evolution of implants placed in the case of diabetic patients [15]. Although one patient had HbA1c values higher than 8%, bone healing or osseointegration of the 5 implants that this patient received was not affected. However, this case cannot be considered relevant and it is stressed out that keeping HbA1c values below 8% is required for healing with a minimum risk.

Regarding the bone response to masticatory forces which were applied after the prosthetic loading of the dental implants, it was observed that the highest bone resorption rate occurred within 3 months of prosthetic loading. Subsequently, the bone resorption rate diminished. The results are similar to those obtained by other studies, which evidence a higher bone resorption rate within 12 months of dental implant placement, and a subsequent decreasing tendency of bone loss [16,17]. This diminution of the peri-implant bone resorption rate can be explained in the context of internal bone architecture remodeling under the influence of chronic external forces [18]. As a result of masticatory forces exerted by dental implants, trabecular bone remodeling occurs to counteract masticatory forces. It seems that as peri-implant bone tissue matures, it becomes dimensionally stable. The data obtained in this study are similar to those obtained in studies analyzing patients without associated pathology [16,17].

Although the number of cases is reduced and the number of monitored implants is limited, the obtained data seem to suggest that there are no changes in the response to masticatory forces transmitted by dental implants placed in diabetic bone compared to non-diabetic bone. However, as previously mentioned, a limitation of this study is the small number of cases as well as the short patient follow-up period. This direction of research needs to be further studied in order to achieve an optimal oral rehabilitation of edentulous diabetic patients.

Conclusions

The mandibular bone response of diabetic patients to masticatory forces transmitted by dental implants is similar, under conditions of good glycemic control, to that reported for non-diabetic patients.

REFERENCES

1. **Oates TW, Huynh-Ba G, Vargas A, Alexander P, Feine J.** A critical review of diabetes, glycemic control and dental implant therapy. *Clin Oral Implants Res* 24: 117–127, 2013.

2. **Boyle JP, Thompson TJ, Gregg EW, Barker LE, Williamson DF.** Projection of the year 2050 burden of diabetes in the US adult population: dynamic modeling of incidence, mortality, and prediabetes prevalence. *Popul Health Metr* 8: 29, 2010.

3. **Keenan AV**. Mandibular implant supported complete dentures improved quality of life. *Evid Based Dent* 14: 19-20, 2013.

4. **Cohen A, Horton ES.** Progress in the treatment of type 2 diabetes: new pharmacologic approaches to improve glycemic control. *Curr Med Res Opin* 23: 905–917, 2007.

5. **Asano M, Fukui M, Hosoda H et al**. Bone stiffness in men with type 2 diabetes mellitus. *Metabolism* 57: 1691–1695, 2008.

6. **Vestergaard P**. Discrepancies in bone mineral density and fracture risk in patients with type 1 and type 2 diabetes--a meta-analysis. *Osteoporos Int* 18: 427–444, 2007.

7. **Rosa LB, Bataglion C, Siéssere S et al**. Bite force and masticatory efficiency in individuals with different oral rehabilitations *Open Journal of Stomatology* 2: 21-26, 2012.

8. **Van der Bilt A, Tekamp A, Van der Glas H, Abbink J.** Bite force and electromyography during maximum unilateral and bilateral clenching. *Eur J Oral Sci* 116: 217-222, 2008.

9. **Bakke M**. Mandibular elevator muscles: physiology, action, and effect of dental occlusion. *Scand J Dent Res* 101: 314-331, 1993.

10. **Parle D, Desai D, Bansal A.** Estimation of individual bite force during normal occlusion using FEA. Altair Technology Conference, India, 2013.

11. **Boven GC, Raghoebar GM, Vissink A, Meijer HJ**. Improving masticatory performance, bite force, nutritional state and patient's satisfaction with implant overdentures: a systematic review of the literature. *J Oral Rehabil* 42: 220–233, 2015.

12. **Kaul AS, Goyal D**. Bite force comparison of implant-retained mandibular overdentures with conventional complete dentures: an in vivo study. *International Journal of Oral Implantology & Clinical Research* 2: 140-144, 2011.

13. **Bornstein MM, Cionca N, Mombelli A**. Systemic conditions and treatments as risks for implant therapy. *Int J Oral Maxillofac Implants* 24(Suppl): 12–27, 2009.

14. **Ghiraldini B, Conte A, Casarin RC et al.** Influence of glycemic control on peri-implant bone healing: 12-month outcomes of local release of bone-related factors and implant stabilization in type 2 diabetics. *Clin Implant Dent Relat Res* Mar 30, 2015. doi: 10.1111/cid.12339. [Epub ahead of print]

15. Courtney MW Jr, Snider TN, Cottrell DA. Dental implant placement in type II diabetics: a review of the literature. *J Mass Dent Soc* 59: 12-14, 2010.

16. Figliuzzi MM, Giudice A, Cristofaro MG, Pacifico D, Biamonte P, Fortunato L. Postextractive implants in aesthetic areas: evaluation of perimplant bone remodeling over time. *Ann Stomatol (Roma)* 6: 29-34, 2015.

17. Tavakolizadeh S, Vafaee F, Khoshhal M, Ebrahimzadeh Z. Comparison of marginal bone loss and patient satisfaction in single and double-implant assisted mandibular overdenture by immediate loading. *J Adv Prosthodont* 7: 191-198, 2015.

18. Colloca M, Blanchard R, Hellmich C, Ito K, van Rietbergen B. A multiscale analytical approach for bone remodeling simulations: linking scales from collagen to trabeculae. *Bone* 64: 303-313, 2014.