Abstract

Aims. – To assess the success of dental-implant treatment in patients with diabetes.

Background. – Dental-implant treatment is an efficient means of replacing lost teeth. However, diabetes can be considered a relative contraindication for this type of treatment because of the slightly higher failure rate compared with populations without diabetes.

Recommendations. – Prerequisite selection of suitable diabetic patients, eradication of co-morbidities (poor oral hygiene, cigarette-smoking, periodontitis), stabilization of glycaemic control (HbA1c at around 7%) and preventative measures against infection can increase the success of dental implantation in diabetic patients to a satisfactory rate of 85–95%.

Conclusion. – Implant surgery is never a matter of urgency; thus, diabetes patients with the best chances of success should be conjointly selected and prepared by both dental and diabetes clinicians.

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Keywords: Diabetes mellitus; Dental implant; Edentulous patients; Review

1. Introduction

There is considerable evidence to suggest that periodontal disease and diabetes are linked in a reciprocating cycle. Diabetes is a risk factor for periodontitis, which appears to develop at least twice as often in diabetics as in populations without diabetes [1]. In addition, periodontal infection can affect glycaemic control in diabetic patients [2]. These coexisting conditions can lead to the gradual loss of tooth attachment to alveolar bone, resulting in tooth loss. Becoming partially or totally edentulous is the possible outcome, and is known as the “sixth complication” of diabetes. However, diabetes specialists are unfamiliar with dental pathology, and are not particularly concerned about either the prevention or cure of dental and periodontal complications,
preferring to refer their patients to a dentist’s expertise and care. Nevertheless, most professional recommendations suggest the usefulness of a dialogue between these two different specialists regarding diabetic patients’ dental care [3]. Indeed, diabetologists are frequently questioned by their patients or by dental clinicians regarding the indications and/or absence of contraindications for dental endosseous-implant treatment.

Dental-implant treatment is an efficient means of replacing lost teeth [4]. However, diabetes has been considered as a risky condition, as it can cause delayed healing, unstable fibrointegration and infections. Treatment can fail because of premature loss of the implant or defects in osseointegration, leading to eventual implant failure. Accordingly, diabetes remains a relative contraindication for implant therapy [5]. To improve the global success rate and reduce the risk of complications, both the identification of suitable patients for such treatment and standardization of its procedures are needed.

2. Diabetes and tooth loss

The oral complications of diabetes can greatly increase the risk of becoming partially or totally edentulous. The causes are manifold: gingivitis, periodontal disease, xerostomia, increased susceptibility to infection, caries and periapical lesions may all lead to increased rates of tooth extraction [6,7]. The risk of deterioration of metabolic control by not eliminating the causes of chronic infection can also lead the dental clinician to anticipate tooth extraction in some cases, which can be problematic for patients. Loss of teeth can impair nutrition by causing chewing difficulties; it can also impair speech and adversely affect the patient’s facial appearance. For these reasons, treatment with dental endosseous implants is an elegant and efficient solution to these problems.

3. Endosseous-implant treatment

The implant has an artificial titanium root (Fig. 1) that is surgically buried in the maxillary or mandibular bone. A prerequisite condition is that there must be sufficient osseous bone surrounding the implant – approximately 1 mm in depth. An intimate relationship between the bone and the implant becomes established during the healing process, known as “osseointegration” [4]. This process is indispensable for the stability and longevity of the implant, which secondarily supports the prosthetic element.

Failure or absence of osseointegration is mostly characterized by the loss of bone around the base of the implant. This complication can be dramatic, as the thickness of the alveolar bone is relatively small. Indeed, the result could be loss of the whole of the alveolar bone. When the quantity of osseous bone is insufficient to accept an implant, either because of physiological, pathological or iatrogenic loss, it is possible to enlarge the implantation site with a contribution of autogenous bone or of replacement biomaterials, or a combination of these two methods [8–10]. Modifications may also be made using a natural cavity (particularly the maxillary sinus) or using bone in apposition to the defect.

The length of the implant varies according to the clinical situation (quantity of residual bone), although short and wide implants generally have better rates of success. They are especially preferred for posterior areas, where bone thickness is particularly reduced, to avoid risky osseous surgery [11–13]. Since the first use of osseointegration, scientific advances have led to improvements in several implantation techniques [14,15]. The initial technique, comprising two surgical sequences (burying the implant, with a healing process lasting 3–6 months; then surgically attaching the prosthesis to the implant), was considered too long. In response, a one-step operating technique was developed in which a gingival connecting element was set up at the same time as the implant procedure. This allowed immediate connection of the prosthesis, which then served as a sort of plug. The choice of technique depended mainly on the experience of the dental clinician. Thus, although endosseous-implant treatments can be efficacious for the replacement of lost teeth, diabetes is still considered a risky condition when undertaking such treatment [5].

4. Implants and diabetes

A literature review has confirmed the value of this type of treatment for type 2 diabetes patients. However, few studies have compared the success rate of dental intraosseous implants in diabetic patients and in healthy, non-diabetic populations. These series do suggest, nevertheless, that there is a greater risk
associated with diabetes, although the amplitude of the risk appears to vary. In the study by Morris et al. [16], 255 diabetic patients from a cohort of 613 subjects were analyzed. The failure rate for dental intraosseous implants was only slightly higher in the diabetic group compared with non-diabetic subjects (7.8% vs 6.8%, respectively). In contrast, a study by Moy et al. [17] found a marked difference between diabetics and non-diabetics (14% vs 4%, respectively), resulting in a relative risk of 2.15 for failure in patients with diabetes. Alsaadi et al. [18], in a population of 2004 subjects, could find no link between the presence of diabetes and implant failure using multivariable analyses. However, it should be noted that global failure rates for dental-implant treatments in diabetic patients have been highly variable between published series, ranging from 4.4% to 14.3% (Fig. 2) [19–27]. Heterogeneity in eligibility criteria for implantation in different diabetic populations may explain the wide between-study variations [27].

The quality of glycaemic control in diabetes is an important factor for the success of dental implants. Oates et al. [28] stratified a population of patients with type 2 diabetes into four groups according to HbA1c values – specifically, less than 6%, 6–8%, 8–10% and more than 10%. In the latter two groups, they observed a significant decrease in implant stability at 2 and 4 weeks compared with baseline values. They also found delayed healing in these two higher HbA1c groups, and no significant increase in stability by week 16 compared with the start of the trial. In contrast, the two lower HbA1c groups, reflecting good glycaemic control, did not exhibit these complications. In addition, Tawil et al. [29] showed that the implant failure rate was significantly lower in patients with HbA1c values less than 7% compared with those who had less well-controlled diabetes (HbA1c 7–9%).

Another factor contributing to implant failure could be the duration of diabetes. Olson et al. [23], in a series of 187 implants in 89 diabetes patients, observed that, among multiple parameters, only duration of disease and implant size (length) were significantly associated with failure of implantation. However, Tawil et al. [29] found that, in a population of diabetic patients with a narrow range of HbA1c values, long-term diabetic disease was not associated with more implant failures.

In fact, there are multiple deleterious mechanisms associated with chronic exposure to high plasma glucose that may affect implant success. Animal experiments of both type 1 [30] and type 2 [31,32] diabetes have confirmed that osseointegration is impaired in hyperglycaemic conditions, and that this anomaly can be overcome by insulin [33] or aminoguanidine supplementation, the latter being an inhibitor of advanced glycation end-product (AGE) formation [34]. Hyperglycaemia acts at several levels to impair osseointegration (for a review, see Javed and Romanos [35]). The quality of clotting is decreased, and microangiopathy impairs bone healing. Osteoblasts, which are involved in bone remodeling in the vicinity of the implant, are decreased in number and less active, and some degree of osteoclast recruitment occurs. Fibrosis is also increased, especially during the early phase after the dental implant has settled.
These anomalies could be responsible for the delay in achieving stability. Healing may be a late occurrence, sometimes not till 6 months after implantation. Also, during the first weeks of implantation, the bone-to-implant contact is looser in those with diabetes [36,37], while empty bone lacunas are more frequently seen in diabetic patients. Inflammatory processes are also increased in chronic hyperglycaemia. Overexpression of the genes coding for proinflammatory cytokines, such as interleukin (IL)-6, IL-8 and tumour necrosis factor (TNF)-α, and some chemokines, such as monocyte chemotactic protein (MCP)-1, and C–C chemokine receptor (CCR)-2 and -4, have been observed in peri-implant biopsies from diabetic patients [38]. These cytokine anomalies were more pronounced in poorly controlled diabetes patients. In addition, in this patient population, all mediators were positively associated with the severity of peri-implantitis. The resulting fibrosis can lead the healing process towards less stable fibrointegration instead of osseointegration. Mechanical stresses can also amplify such distortions during implant integration.

It is noteworthy that co-morbidities interfere adversely with the healing process (see the review by Lindhe et al. [39]). Indeed, poor oral hygiene, cigarette smoking and a history of periodontal disease all worsen the prognosis. Inappropriate control of the healing process resulting in less stable fibrointegration instead of osseointegration. Mechanical stresses can also amplify such distortions during implant integration.

As for the type of implant, failures may be more frequent with thin and short implants [23], whereas wide and short implants apparently have better results [13]. However, the texture of the material does not appear to influence the quality of osseointegration. Also, there was a positive correlation between the number of adjacent implants and failure rate, as reported by Loo et al. [40] in a series of 138 diabetic patients. Those patients with three adjacent implants, and 31 of 72 cases with two adjacent implants, had a failed implant, whereas the failure rate with only one implant was 25%.

Prevention of infection may also be important. In the Morris et al. [16] study, the use of a chlorhexidine rinse reduced the failure rate in type 2 diabetes patients from 13.5% to 4.4%. In addition, preoperative antibiotic coverage decreased the failure rate in the same population from 13.4% to 2.9%. In agreement with such findings, a Cochrane analysis [41] in non-diabetic subjects found that a greater number experienced implant failures when they did not receive antibiotics: risk ratio, 0.40; 95% confidence interval (CI), 0.19–0.84. The number-needed-to-treat (NNT) to prevent one patient from having an implant failure was 33 (95% CI, 17–100).

The satisfaction of diabetic patients after an overdenture implant support was slightly better than that of patients fitted with conventional dentures. The improvements were significant in terms of chewing ability, comfort and range of food choices [42].

5. Practical considerations

Diabetes is not an absolute contraindication for dental osseointegration treatment [5,27]. In fact, the global success rate, as observed in well-controlled diabetic patients, is good (85–95%), and only slightly lower than in healthy, non-diabetic populations. It is worth noting that implant surgery is never a matter of urgency. This means that, prior to the procedure, dental and diabetes specialists can verify that the treatment has a reasonable chance of success. In this case, patients with chronically uncontrolled diabetes associated with multiple systemic complications and/or co-morbidities should not be eligible for this type of treatment, whereas conventional solutions, such as a bridge or a partially removable prosthesis, may be more suitable for these at-risk subjects. For others, the implantation procedure may require some preparation, such as improvement in metabolic control. Although a few successful outcomes have been reported in patients with very high levels of HbA1c [37], most authors insist on an HbA1c less than 8% before dental implantation is carried out [5,27,35]. It should be noted that this proposed target is higher than is usually recommended for type 2 diabetes patients. Accordingly, an HbA1c value close to or less than 7% may be a more reasonable objective.

Despite data from animal models suggesting specific beneficial effects [33], insulin does not appear to be better than oral hypoglycaemic agents that stabilize plasma glucose. Furthermore, co-morbidities should be taken into account, and the restoration of proper oral hygiene, cessation of tobacco use and smoking, and intensive treatment of periodontitis should also be required.

Some decisions are matters for the dental clinician, such as the choice of implant, the choice of surgical technique and whether the surgery is conducted in one or two phases, as well as the avoidance of functional mechanically excessive loads (particularly within the first year of implantation).

The prevention of infection should be systematically applied. Preoperative antibiotic therapy could consist of amoxycillin 2 g at 1 hour before surgery or 1 g before surgery plus 500 mg four times a day for 2 days [42]. Other antibiotics suitable for preoperative prevention include clindamycin, azithromycin and clarithromycin. First-generation cephalosporins (cephalexin, cefadroxil) may also be options in the absence of any history of allergic reactions to penicillin [27]. One author [36] has proposed prolonged pre- and post-antibiotic prophylactic therapy for diabetic patients (amoxycillin 2 g, then 500 mg three times a day for 5 days, followed by 250 mg four times a day for 5 days). However, the superiority of such a prescription has not been confirmed. In addition to antibiotic prophylaxis, mouthwashes including 0.12% chlorhexidine are recommended during the 2 weeks following surgery, with follow-up to prevent complications. Peri-implant inflammation [39] can be diagnosed by conventional probing; using a light force of 0.25 N and the supporting bone level can be assessed by radiography. Peri-implant diseases include peri-implant mucositis (redness and swelling of soft tissues, and bleeding on probing) and peri-implantitis (suppuration, deepened pockets and loss of supporting marginal bone). Mechanical, antimicrobial and surgical treatments are available, but all have low levels of predictability [39].

Furthermore, clinicians need to inform patients that they have an increased risk of peri-implantitis. However, in well-selected diabetic patients, and after eradication of co-morbidities,
improvement of metabolic control and prevention of infection, dental osseointplantation has a reasonable chance of success-fully replacing missing teeth, even though the failure rate remains slightly higher than that observed in healthy, non-diabetic people. In diabetes patients considered ineligible for an implant, more conventional treatments, such as a bridge or a removable prosthesis, should be preferred.

6. Conclusion

Dental-implant surgery is feasible in selected diabetic patients with the proviso of careful patients’ preparation and follow-up. These conditions reinforce the need for a dialogue between dental clinicians and diabetologists in order to offer diabetic patients the best chances of success with tooth-replacement procedures.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


