Dental implant Management in Diabetic Patients: Risks and Challenges

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Abstract:- The current study aimed to examine the management of dental implants in diabetic patients in terms of risks and challenges. The rise in the diabetic population around the world has become a major concern for society, and persistent high blood sugar may affect all tissues, thus leading to morbidity and eventual mortality. In diabetic patients. A direct negative response of diabetes to oral tissues has been observed with some discrepancies, but little is known about the effect of diabetes on dental implant treatment and its consequences. Many studies concerned with Osseo integration and prognosis of dental implants in diabetic patients have been performed and published since 1994. These studies have been critically reviewed to understand the impact of diabetes on the success of dental implants and implants in diabetics, the relationship between dental implants and diabetes, dental implants and diabetes, conditions for dental implants for diabetics, the possibility of dental implants for diabetics being possible, and how a diabetic patient maintains On his teeth, solutions to the problems of dental implants and gum infections for diabetics, the relationship between diabetes and tooth decay, the importance of dental implants for diabetics, the benefits of dental implants for diabetics, the most effective and safe implant methods, post-dental implant care for diabetics, and important advice for diabetics before implants. Teeth, the cumulative sugar level for dental implants, treatment of gingivitis after dental implants, installing dentures for diabetics, and the harms of dental implants for diabetics..

Keywords: Dental implant - Management - Diabetic Patients- Risks – Challenges.

Introduction :

The literature and theoretical studies in diabetic animals demonstrate a high rate of dental implant failure, but most clinical studies have reported statistically insignificant dental implant failure even in fairly uncontrolled diabetic patients.

The success of dental implants in diabetic patients who are well and fairly controlled with proper treatment planning, preventive treatments and adequate post-operative maintenance appears to be as good as in normal individuals.

The relationship between dental implants and diabetes: Diabetes affects millions of people around the world, primarily affecting blood sugar levels(106).

Although it has a negative impact on various aspects of a person's health, one important area of concern for individuals with diabetes is the possibility of undergoing a dental implant procedure. Information about diabetes: Before talking about dental implants for diabetics, we will learn together the most important information about diabetes, and we will list it in the following points:

• Diabetes is a chronic disease that occurs when the pancreas does not produce a sufficient amount of insulin, or when the body is unable to use the insulin it secretes.

• Insulin allows the body to use sugar to produce the energy it needs.

• In the case of diabetes, the blood sugar level increases, which may expose a person to serious medical conditions such as heart and kidney disease and loss of vision.

• There are two types of diabetes. The first type occurs at any age as a result of an immune defect in the body and in which the patient takes insulin throughout his life. The second type is the most common and does not cause any symptoms at first, and it is possible to avoid it by adhering to a healthy diet and physical activity(13).

The recent studies in China[1] and India[2] has shown that the number of diabetic individuals has surpassed the estimate of IDF-2009[3] i.e., approximately 285 million people worldwide will have diabetes in 2010 and by 2030, 438 million people of adult population is expected to have diabetes with majority of effected population from China, India and USA(66).

The comforts like natural dentition, conservative treatment compared to teeth supported FPDs and long term success for the edentulous patients, as well as partially edentulous patients have made dental implants supported prosthetic treatment as an attractive substitute to traditional removable or fixed dental prosthesis besides being costly and lengthy procedures with

surgical intervention.[4,5,6] The growing economy of developing nations like china and India has also been playing a key role in popularizing the implant dental treatment. In light of above facts, the dental fraternity may encounter with more number of diabetic patients for dental implant treatments(99).

The relationship between dental implants and diabetes patients:

As for the relationship between dental implants and diabetes, some studies have shown that stable cases of diabetics have no risk of developing complications after dental implant procedures, while uncontrolled diabetes patients have higher rates of infection and implant failure after the procedure. Speaking of dental implants for diabetics, patients with uncontrolled diabetes face more difficulty in the healing process due to the effect of diabetes on the nerves, so the doctor will ask you to control your blood sugar level before performing the implant. If you are one of the diabetics who want dental implants to replace the ones they lost; Do not hesitate to visit us at the Granti Center, and our medical team at the center will provide you with all the information about diabetics and dental implants, and whether or not this procedure is suitable for you. Dental implants and diabetes: Conditions for dental implants for diabetics: Can a diabetic get dental implants? A question that many diabetics ask before considering dental implants. Perhaps the most important condition for dental implants for diabetics is to control the blood sugar level and maintain it within normal levels before dental implants are performed(28).

Among the conditions associated with diabetes and dental implants are:

• The jaw has sufficient bone density to support dental implants.
• The safety of the gums and surrounding tissues from infection and inflammation.
• The use of oral antiseptic solutions in the pre- and post-operative stages reduces the rate of complications and infections during wound healing(87).
• Treatment with antibiotics before and after surgery to avoid infection during the early stages of wound healing after surgery.
• Antibiotic treatment should begin one hour before surgery and continue until recovery. • Rinse mouth before and after surgery with a mouthwash containing 0.12% chlorhexidine gluconate.
• It is important to follow your dentist's care instructions after surgery, including any dietary restrictions, antibiotics, and maintaining oral hygiene(54).

Possibility of dental implants for diabetics:

Of course, a diabetic patient can have dental implants.
If his diabetes is under control, there is no objection to performing dental implants, as the success rate of dental implants for diabetics is similar to the success rate for normal people and is about 96.4% and often reaches 100%, and this applies to Diabetes type 1 and 2(54).

The duration of implant survival in diabetic patients can be improved by receiving appropriate care before and after dental implants, and of course the most important thing is controlling blood sugar levels. When blood sugar levels are stable, the risks associated with diabetes are reduced. We cannot end our conversation about dental implants and diabetes without knowing how a diabetic patient maintains the health of his teeth. Follow our next paragraph to find out the answer(13).

Ways for a diabetic patient to maintain his teeth: Although taking care of dental hygiene is something indispensable for everyone, for diabetics it is a very thorny matter, as diabetes affects the health of the mouth and teeth greatly, so there are some tips on how to take care of teeth for a diabetic patient:

• The most important thing is to control diabetes, to avoid health risks associated with high blood sugar levels, including damage to the mouth and teeth.
• Have regular checkups and visit the dentist regularly, at least every six months, for dental checkups and cleanings.
• Maintain oral and dental health by flossing at least twice a day with fluoride toothpaste and a soft toothbrush, and using dental floss or interdental brushes to clean between the teeth.
• Treating gum disease, as diabetics are more susceptible to gum disease, so if you suffer from some symptoms such as bleeding gums after cleaning tartar, swelling, or constant bad breath, you should consult a doctor for treatment.
• Of course, as a diabetic, you must abstain from eating sugars to avoid high blood sugar levels and tooth decay.
• Avoid smoking and drinking alcohol. Oral and dental centers are distinguished by the following: • Applying the latest scientific methods, therapeutic and preventive methods for dental treatment.
• The center is distinguished by providing services of the highest quality, using the latest technologies and modern tools in the field of dentistry and implantology.
• The center includes the most skilled dentists in multiple specialties, including teeth whitening, orthodontics, and of course dental implants. • The center offers multiple options of materials at various price levels to suit the needs of all individuals.
• The center adheres to all rules of privacy and medical confidentiality of patient information.
• The center provides care and follow-up before and after dental implants to ensure the success of the procedure(103)(105).

Diabetes mellitus is a chronic disorder of carbohydrate metabolism characterized by hyperglycemia, reflecting distortion in physiological equilibrium in utilization of glucose by tissue, liberation of glucose by liver and production-liberation of pancreatic anterior pituitary and adrenocortical hormone. The debilitating characteristic of diabetes mellitus was known as early as in second century AD, when Areteous named it as diabetes means "a siphon" as he perceived that the condition was characterized by melting down of flesh and limb into urine.(7) Various modern research and discoveries have shown that diabetes mellitus, more or less, affects every tissues of body directly or indirectly through late complications (8).

Concerning the effect on oral tissues, Loe.(9) recognized the periodontal disease as sixth major complication of diabetes. Number of studies has proved the adverse effect of chronic hyperglycemia on oral mucosa and with some controversies on alveolar bone.

The effect of anesthesia on a diabetic patient:

When the body is under the influence of anesthesia, it is exposed to great stress, which leads to increased production of hormones such as cortisol, adrenaline, and glucagon, which raise blood glucose levels(23).

Diabetes and tooth decay: Diabetes does not directly cause teeth to break, but it affects your oral health in several ways that may increase your risk of tooth breakage.

Diabetes can reduce blood flow to the mouth, change the amount of saliva, and weaken the immune system, making you more susceptible to infection and inflammation(48).

The gums and bones that support your teeth. Solutions to dental implant problems and gum infections for diabetics:

Figure (1)

The National Research Center recently organized a scientific symposium on the latest technologies in the field of dental implants to treat the biggest problem affecting oral and dental patients, which is tooth loss(67).

Researchers point out that not replacing them in the correct way causes many dental and oral problems, and also affects the patient's general health(54).

The research dealt with the latest applications of genetic engineering in dental implants, modern methods of implantation, and making measurements.

It also provided solutions to the problems facing dental implants, especially in patients with diabetes and chronic gum infections.

Diseases that prevent dental implants, the most common of which are diabetes and chronic and acute gum infections(50).

She pointed out that there are some obstacles facing dental implants for these patients, the most important of which are lack of stability and their vulnerability to falling out after a short period. From its composition, she points out that it is very important for diabetics to perform a glycated hemoglobin analysis to ensure that they are a regular diabetic, and this provides a greater chance of the implant's success. She adds that modern types of lining materials can currently be used for dental implants, which are characterized by reducing the forces exerted on the jaw bones and gums, thus reducing gum infections and jaw bone erosion and increasing the stability of the implants(88).

These types are distinguished by their positive effect on oral health, the absence of any collateral damage to the gums, and they give an aesthetic appearance to the mouth, in addition to being more stable and easier. In use over traditional types. Plasma and dental implants: Regarding the latest applications of genetic engineering in the field of dental implants(39).

Measures for improving success of dental implant in diabetics

Good glycemic control, preoperative and post-operative, is required to achieve improved osseointegration in diabetics (51) .

Prophylactic antibiotics have shown to be effective for success of dental implants in diabetic patients and use of 0. 12% chlorhexidine further improves the success rate.(45,48,49,50,51,52)Certain factors like implant surface characteristics (implant coated with bioactive material) and higher implant length and width has been shown to improve success rate of implant in diabetic patients. Some researcher has found positive results in experimental studies to improve osseointegration and results are yet to be verified in human being. In few studies,[53,54] it was observed that systemic administration of aminoguanidine reduced the deleterious effect of diabetes on osseointregration. Satana et al.[55] used rhFGF2 (recombinant human fibroblast growth factor-2) encapsulated with poly glycosylated poly lactide (PGLA) membrane in calvarial defect of diabetic rat and formation of normal bone level was observed in histomorphic analysis. Wang et al.,[56] in a study based on similar concept, used rrIGF-1(Recombinant rat insulin like growth factor) encapsulated with PGLA around Ti implant inserted in calvaria of diabetic rat. It was found in histomorphic analysis that diabetic rat with rrIGF-1 had higher BIC around the implant compare to rat without rrIGF-1 after 4-8 weeks of surgical placement. A recent hypothesis was made by Bai et al.(57) that adiponectin, an insulin sensitive adipokine may improve osseointregration in diabetic patients by infusing it systemically or using locally as it has shown potent anti-inflammatory properties and increased bone density by enhancing osteoblast and inhibiting osteoclast formation.

Diabetes and its effect on gum health:

- Diabetes is a chronic condition that causes high blood sugar levels.

-People suffering from diabetes suffer from a lack of insulin secretion or the body's resistance to this hormone. Diabetes affects gum health and may lead to gingivitis.

-When blood sugar levels are high for a long time, the risk of gingivitis increases. Patients with diabetes may notice that their gums are red, swollen, and bleed easily during brushing.

-This is due to the accumulation of plaque (bacteria) on the teeth and gums due to high blood sugar levels. If gingivitis is not treated, it can lead to more serious problems such as erosion of the bone supporting the teeth and tooth loss(72).

Diabetes and its effect on Teeth:

In addition to affecting gum health, diabetes can also affect dental health. High blood sugar may cause bacteria to multiply in the mouth, increasing the risk of tooth decay(44).

People suffering from diabetes can be susceptible to tooth decay due to the high level of sugar in saliva. In addition, sugar consumed in food and drinks can lead to the erosion of enamel (the tough outer layer of the tooth) and the formation of tooth decay. Therefore, patients with diabetes are advised to follow a healthy diet and limit their intake of sugars and sugary soft drinks(35).

Benefits of dental implants for diabetics: Dental implants are a surgical procedure aimed at replacing missing teeth using artificial implants. Dental implants for diabetics are considered one of the effective treatment options for diabetics who suffer from tooth loss. It has many important benefits for the patient's oral health and overall function(69).

• Gum improvement: Thanks to dental implants, the gingival tissue is restored and strengthened, leading to improved gum health and reducing gingivitis problems.

• Improving speech and chewing: Dental implants help restore the ability to speak clearly and chew food properly, which contributes to improving the patient's health and general quality of life.

• Aesthetic appearance: Dental implants restore the vitality of the smile and improve the patient's aesthetic appearance, which enhances self-confidence and psychological comfort. Restoring the ability to chew: One of the effects of diabetes is the loss of teeth, and this negatively affects the ability to chew and properly digest food(52).

Dental implants restore the diabetic patient's ability to chew properly, which contributes to better digestion of food and full use of nutrients(90).

Dental implants are important for diabetics to improve oral health, chewing ability, and improve the overall quality of life(8).

It is necessary to take care of the teeth and gums and consult a dentist to obtain the necessary care(17).

Necessary preparations before dental implants for a diabetic patient: Evaluation of the patient's general condition: Before dental implants are performed on a diabetic patient, their general condition must be carefully evaluated(87).

You should consult a dentist to examine the mouth and determine the presence of any other problems such as gingivitis, tooth decay, or neuritis(102).

Preparing the mouth and Teeth:

It is important that the mouth and teeth are prepared before dental implants are performed for diabetics. It should be ensured that the adjacent teeth and gums are healthy to ensure the success of the implant(103).

Patients may need additional procedures such as teeth cleaning or removal of irritated teeth before starting the dental implant procedure(49).

Preparations made by the medical staff and the diabetic patient before the dental implant procedure is very important to ensure the success of the procedure and avoid any health problems(51).

Diabetic patients must adhere to medical advice and take good care of their oral and dental health to maintain good dental implant results and improve their quality of life(41).

The most effective and safest farming methods Before performing dental implants on a diabetic patient, the most effective and safest implantation methods should be provided(99).

Among the common methods of dental implants are screw dental implants and mini dental implants. The screw is placed in the bone and fixed well, then the dental prosthesis is installed over it(16).

As for mini dental implants, they are used when the bone is not enough to implant the screw, and a plastic cap is placed in the bone to insert and stabilize the artificial root(28).

Preparing the mouth and cleaning the remaining Teeth:

Diabetics who intend to have dental implants need to prepare the mouth and clean the remaining teeth carefully(11).

A complete dental cleaning should be performed to ensure that there are no cavities or gum disease. Additional procedures such as removing irritated teeth or restoring cavities may be needed before the implant is performed. After preparing the mouth and cleaning the remaining teeth well, the dental implant procedure can begin(36).

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Preparing the Mouth and Cleaning the Remaining Teeth:

Diabetics who intend to have dental implants need to prepare the mouth and clean the remaining teeth carefully.

A complete dental cleaning must be performed to ensure that there are no cavities or gum diseases. Additional procedures such as removing irritated teeth or cleaning cavities may be necessary before the implant is performed.

After preparing the mouth and cleaning the remaining teeth well, the dental implant procedure can begin.

Post-implant care for diabetic patients:

Necessary care procedures for wounds and swelling:

After dental implants are performed on a diabetic patient, necessary care must be taken for wounds and swelling to ensure proper recovery.

The mouth should be gently rinsed with salt water to clean the wound and keep it clean.

It is also possible to use a recommended disinfectant solution.
You should avoid eating hot and solid foods in the first days after the operation to reduce swelling and reduce inflammation.
It is also recommended to take strictly prescribed medications to relieve pain and swelling.

Recommendations for Proper Nutrition and Maintaining Oral Health:

After dental implants for a diabetic patient, diabetics must follow recommendations for proper nutrition and maintaining oral health.

It is recommended to eat balanced meals that contain the proteins, vitamins, and minerals necessary to promote wound healing and maintain dental health.

You should avoid eating sugary foods and sticky foods that can build up around the teeth and cause cavities.

You should also brush your teeth, floss, and rinse your mouth regularly to keep your gums and teeth healthy.

Important tips for diabetics before dental implants:

- Maintain a healthy diet Before having dental implants, diabetics are advised to maintain a healthy and balanced diet.
- You should eat meals rich in proteins, vitamins and minerals to promote wound healing and good recovery after the operation.
- It is recommended to avoid eating foods rich in sugar and refined carbohydrates, as they can affect the blood sugar level and hinder recovery.
-On the other hand, it is important to avoid excessive fasting before surgery, and make sure to eat a light and balanced meal before the operation.
- Daily dental care To prepare the mouth for implants, diabetics must follow good daily dental care.
-It is recommended to use a soft toothbrush and toothpaste linked to blood sugar level, to clean teeth well.
- You should also use dental floss regularly to get rid of debris and germs that can accumulate between the teeth. It is also recommended to visit the dentist for a professional cleaning and periodic examination of the teeth and gums before the procedure to ensure their safety.
- Cumulative blood sugar rate for dental implants.
- Treating gingivitis after dental implants.
- The cumulative blood sugar level is one of the important criteria that must be taken into consideration before performing a dental implant procedure for diabetics.
- It is known that diabetics suffer from disturbances in blood sugar levels, and this directly affects the process of wound healing and recovery after surgery.

Diabetic patients are more susceptible to developing gum infections and erosion of the bone surrounding the teeth.

When a tooth is implanted, bacteria can easily spread to nearby areas and cause infections. Therefore, diabetics should pay attention to personal hygiene and oral care after surgery.

Second, dental implant procedures may require a combination of medications and antibiotics. This means that diabetics need to pay extra attention to blood sugar levels and adjust medication doses in coordination with the specialist doctor.

In general, dental implants can be safe for diabetics if medical guidelines are followed and good oral care is taken care of. But it is important for patients to be aware of the potential risks and work in coordination with the healthcare team to avoid any complications that may arise from dental implants. Best toothpaste for diabetics

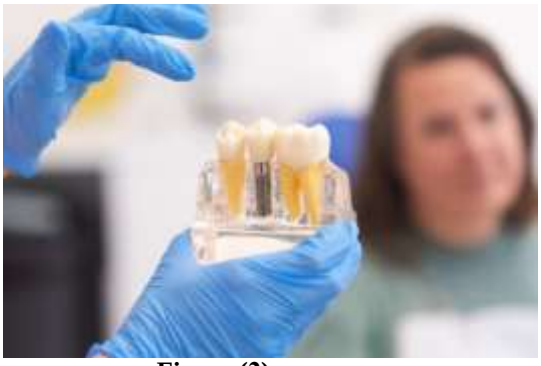

Figure (2)

Dental care is one of the most important factors that diabetics should pay great attention to. One of the important types of dental care is choosing the best toothpaste that suits the condition of diabetic patients. Patients with diabetes often suffer from gum problems and tooth erosion.

Therefore, these patients should choose a toothpaste that helps maintain gum health and prevents tooth erosion. One of the best types of toothpastes for diabetics is toothpaste designed to control bacteria and gums.

This type of toothpaste contains antibacterial and soothing substances for the gums, which helps maintain gum health and reduce mouth infections. ‘

There are also other types of toothpastes that contain beneficial natural ingredients such as tea tree oil and aloe vera. .

These ingredients help soothe and disinfect gums and reduce inflammation. It is important for diabetics to consult a dentist to choose the appropriate toothpaste for their health condition, follow his recommendations, and take good care of the mouth, including brushing the teeth regularly and using medical floss to clean the mouth.

Best dentist for diabetics: Diabetics need special care when visiting the dentist.

Therefore, it is important to find the best dentist for diabetics to get proper care and ensure healthy teeth and gums.

It is preferable that the doctor specialize in dentistry for diabetics and have extensive experience in this field. He must be aware of the effect of sugar on patients' oral and dental health and be able to provide appropriate treatment and correct advice. Tooth loss is one of the common problems that diabetics suffer from.

Therefore, the doctor must have the ability to treat and restore tooth loss. He must also have knowledge of the funding available for performing dental implants and provide the necessary information and guidance to patients.

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia (high levels of glucose in the blood) which results from defects in insulin secretion (the pancreas does not produce enough insulin), insulin action (the body cannot effectively use the insulin it produces), or both (1).

The most common type of diabetes mellitus, type 2, which accounts for 90–95% of those with diabetes mellitus (1), was estimated to affect 537 million adults worldwide in 2021, with a prediction to rise to 643 million adults by 2030 (2). Such prevalence highlights the importance of this group of diseases.

Summary of research protocol:

Micro-Implant Design and Characteristics

All micro-implants (Novem, PW plus Company, Nakorn Pathom, Thailand) were made from commercially available pure (CP) titanium grade 4.
The implants have minimal surface roughness by sandblast acid etch technique the same as a commercial dental implant. The implant has 2.5 mm of diameter and 5 mm of length with characteristics of four outer rings and three chambers similar to the implants used in another study (40) (Figure (3).

Figure(3)
Micro-implant design with outer diameters of 2.5 mm and length 5 mm. the implant is designed with 3 bone chambers and 4 outer rings.

Surgical Procedure:

Micro-Implant Placement:

Edentulous area in the maxillary premolar and first molar region both right and left side were included in the experiment protocol with bone diameter of at least 6 mm in order to accommodate the future conventional implant of between 4.2 mm to 5 mm and bone length of at least 10 mm to 12 mm. All of patients in control and test groups first underwent surgical placement of a 2.5 mm × 5 mm micro-implant (Figure (3).

Local anesthesia was administered using articaine 4% with epinephrine 1:100,000 concentration (Septanest SP, Septodont, Saint-Maur-des-Fosses, France) and mid-crestal incision was made using number 15c carbon steel blade (Swann-Morton, Sheffield, England) and full thickness flap was raised using periosteal elevator(81).
Implant bed was made using a cylindrical carbide bur drilled in the middle of the crestal bone and the micro-implant was placed by press-fit technique using percussion manually until all the threads completely embedded in the alveolar bone(60).
The mucoperiosteal flap was then repositioned and 4-0 nylon suture (Sofilon, Novamedic, Samut Prakan, Thailand) was used to close the surgical site(99).

Analgesic (paracetamol 500 mg, GPO, Bangkok, Thailand) and antibiotics (either amoxycillin 500 mg (GPO) or clindamycin 150 mg (GPO) were prescribed for all patients for 3 days and 7 days respectively. Sutures were removed after 7 days post-operation, and wound healing was monitored at 1 week, 4 weeks and 8 weeks after implant placement before retrieval and placement of conventional implants.

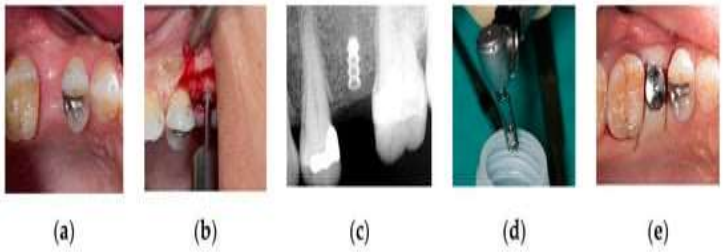

Figure (4)
Surgical placement of micro-implant:
(**a**). Initial situation with one missing tooth on maxillary second pre-molar area;
(**b**). Full thickness flap raised and micro implant was inserted;
(**c**). Periapical radiograph immediately after the surgery;
(**d**). Trephine bur was used to retrieve the implant after 8 weeks of healing;
(**e**). Conventional implant was placed immediately after removal of the micro-implant and healing abutment was used(63).

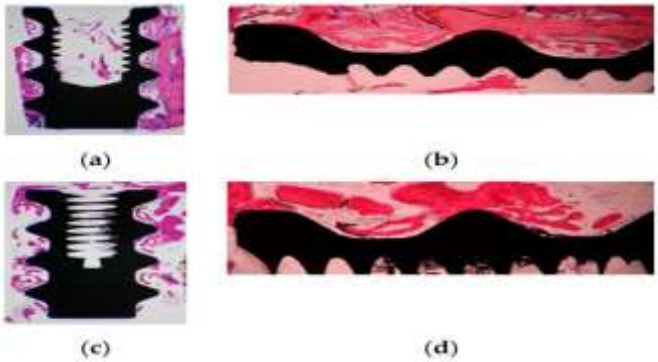

Figure (5)

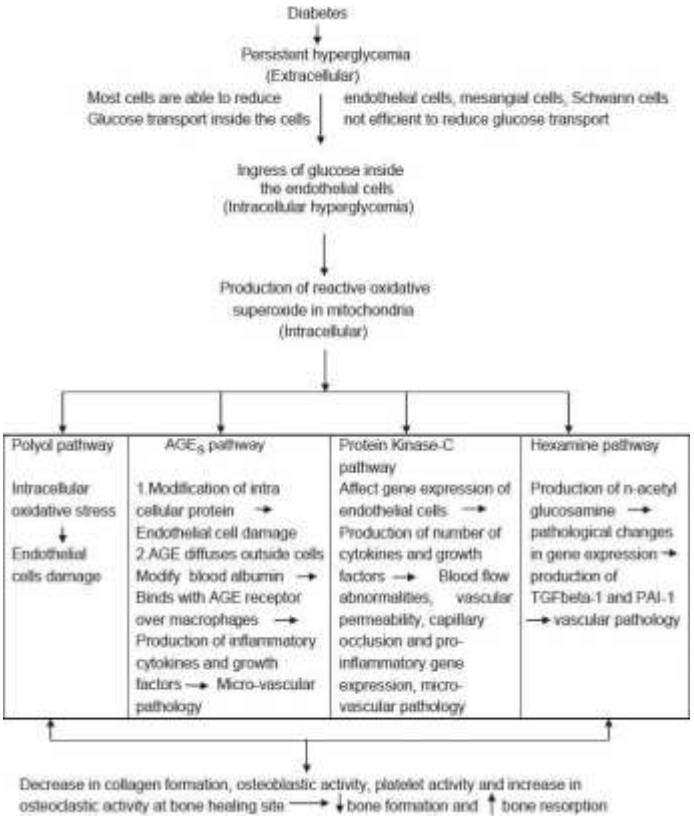

Figure (6)

Possible effects of diabetes over mechanism of osteointegration:

Most of clinical studies reported success of dental implant in diabetic individual as good as normal peoples. The reason may appear to be the inclusion of controlled diabetics in the almost all studies. The persistent hyperglycemia is responsible for development of micro-vascular complication and consequently the early or late implant failure. Hence the uncontrolled level of diabetes, reflected through measurement of glycated hemoglobin HbAc1 (indicate average glucose level over preceding 2-3 months period,(61). level 6 to 8 shows well controlled, 8.1 to 10 moderately controlled and more than 10 shows poorly controlled diabetes), persistent for longer duration with sign of micro-vascular complication may affect the success of dental implant significantly. However, none of the study included such uncontrolled patients or in other word it can be concluded that none of the surgeon had taken risk to insert dental implant in such human beings(104).

Even the fairly or moderately controlled diabetes persisting for very longer duration (more than 10 years) may produce complications and diminish the health of tissues. The compromised condition along with some unfavorable restorative factors may bargain the success of dental implants. Therefore, numerous factors associated with rehabilitation and diabetes itself, more or less, affect the survival of dental implant in diabetic subjects[62] [Table 4]. Cautious consideration of the mentioned factors during rehabilitation improves the success and hence the survival of dental implants in diabetic individuals(100).

Dental health should be a priority for diabetics, and finding the best dentist with expertise in this field can be an important step towards maintaining healthy teeth and keeping diabetes under control(91).

Treatment of tooth decay for diabetics Tooth loss is a common problem that diabetics suffer from(3).

This problem requires special care and treatment to maintain healthy teeth and gums and maintain normal oral functions(87).

Diabetics are vulnerable to developing dental problems due to high blood sugar levels. These problems include loose teeth, gum erosion, tooth decay, and chronic infections of the mouth and gums. Therefore, treating tooth loss is important for diabetics(64).

Treating tooth loss for diabetics includes several steps and practices, such as:

Monitor sugar levels: Diabetics must keep their blood sugar levels under control, as high sugar levels increase the risk of developing dental problems(63).

Maintaining dental hygiene: Diabetics should brush their teeth regularly and effectively, using a soft toothbrush and suitable toothpaste, and use dental floss to remove food residues and deposits between the teeth(17).

Visit the dentist regularly: Diabetics should visit the dentist regularly to check and evaluate the health of their teeth and gums. The doctor can perform the required tooth loss treatments and guide patients on proper oral care. Follow a healthy diet: Diabetics should eat a healthy, balanced diet that keeps blood sugar levels within a normal range(94).

Table 1

Late-onset Complications of Diabetes

Microvascular complications	Macrovascular complications
Retinopathy	Cardiovascular disease
Nephropathy	Peripheral vascular disease
Neuropathy-Peripheral and autonomic	Cerebrovascular disease
Erectile dysfunction	
Periodontal disease	

This review caters actual scenario to practicing dentists regarding success and failure of dental implant treatment in diabetic individuals observed by various studies. The experience based suggestions and experimental studies about increasing osteointegration and consequently improving success rate of dental implant treatment in diabetic patients have also been discussed.

Cost of dental implants: Dental implants are surgical procedures that aim to replace missing teeth with artificial teeth. This procedure is an effective solution to the problems of tooth loss and tooth loss for diabetics. As the number of patients needing dental implants increases, attention to the cost of the procedure becomes important(60).

The cost of dental implants varies depending on several factors, including:
- The number of teeth that need implants.
- The type of implant used, as the cost of traditional dental implants differs from the cost of sliding dental implants with braces.
- The reputation and experience of the treating physician.
- The cost associated with the necessary tests before and after the operation.

It is important to consider that the cost of dental implants may be relatively high, but you should also consider the significant benefits that come with this, such as improved oral function and a complete restoration of your smile and self-confidence.
Therefore, diabetics should take these factors into consideration when evaluating the cost and deciding to undergo the appropriate dental implant procedure(67).

Implants in patients with diabetes mellitus

Diabetes is currently classified as a relative contraindication for implant treatment. Compared with the general population, a higher failure rate has been seen in diabetic patients with adequate metabolic control (20).

Reviewing the literature published in the last 10 years, the survival rate for implants in diabetic patients ranges between 88.8% and 97.3% one year after placement, and 85.6% to 94.6% in functional terms one year after the prosthesis was inserted(87).

In a retrospective study with 215 implants placed in 40 diabetic patients, 31 failed implants were recorded, 24 of which (11.2%) occurred in the first year of functional loading(43). This analysis shows a survival rate of 85.6% after 6.5 years of functional use. The results obtained show a higher index of failures during the first year after placement of the prosthesis (21). Another study carried out with 227 implants placed in 34 patients shows a success rate of 94.3% at the time of the second surgery, prior to the insertion of the prosthesis (22). In a meta-analysis with two implant systems placed in edentulous jaws, failure rates of 3.2% were obtained in the initial stages, whereas in the later stages (from 45 months to 9 years), this figure increases to 5.4% (23).

Special considerations for the placement of implants in diabetic patients

1. Healing and risk of post-operative infection:

The repercussions of diabetes on the healing of soft tissue will depend on the degree of glycaemic control in the peri-operative period and the existence of chronic vascular complications(15).

Patients with poor metabolic control have their immune defences impaired: granulocytes have altered functionality with modifications in their movement towards the infection site and a deterioration in their microbicide activity, with greater predisposition to infection of the wound. In addition, the high concentration of blood-glucose and in body fluids encourages the growth of mycotic pathogens such as Candida(39).

The microangiopathy arising as a complication of diabetes may compromise the vascularization of the flap, thus delaying healing and acting as a gateway for the infection of soft tissue (28).

2. Peri-operative measures:

Alternatives to dental implants: Dental implants are an effective solution to the problem of tooth loss and tooth loss for diabetics. However, some patients may have difficulty getting dental implants due to their health condition(59).

Therefore, there are other alternatives that diabetics can turn to to restore oral function and the aesthetic appearance of their teeth. One possible alternative is wearing dental bridges(88).

Dental bridges attach artificial teeth to the patient's existing natural teeth(71).

These alternatives are suitable for cases where there are natural teeth in the jaw and are ready for support. In addition, diabetics can use removable dentures as an alternative to dental implants. These dentures include gum-based prosthetic teeth that sit on removable gums(91).

These prostheses provide comfort and flexibility for patients, as they can be easily removed and cleaned. - There are also fixed alternatives such as connecting bridges and dental crowns(14).

These alternatives include placing fixed artificial teeth on the remaining teeth or on the agricultural screw. These alternatives are more stable and stable in the mouth, providing greater comfort for patients(26).

- Diabetics should consult a specialist dentist to determine the appropriate alternatives for their condition and meet their individual needs(82).

The goal of dental implant surgery:

Dental implants aim to replace missing teeth using artificial roots over which a crown made of zirconium is placed, which is indistinguishable from natural teeth(17).

The operation is performed after a comprehensive examination of the teeth and jaw bones to ensure their readiness for the transplantation process(64).

If the patient does not suffer from any deformity or problem that hinders the procedure, the transplantation steps begin, which proceed as follows:

The examination and installation stage of the artificial root: the first stage of the procedure, during which the dentist implants titanium roots in the patient's jaw under the influence of local anesthesia(74).

The transplanted root is left for a period ranging from three weeks to three months or more, depending on the patient's condition, in order for it to fuse well with the jaw bones(100).

Crown dressing stage:

The doctor begins this stage after ensuring that the root is fused with the jaw. The doctor places a crown of the same size, color and shape as the patient's teeth(83).

Surgery is performed in the previous steps for those who suffer from the problem of losing some of their teeth, but does implantation work in the same way for diabetics.

Success/failure of dental implants in diabetic patients

Most of the studies(43,44,46,48) observed slightly high percentage of early failure of implants in diabetics compared to late failure. Some reports(45,46,50) indicated increased failure rate within first year of placement of implant. The published retrospective and prospective studies data, retrieved through various sources from 1994 to 2011 indicated that the success rate of dental implants in diabetic patients were in range of 85.5-100% and were comparable to the non-diabetic patients.

Most of the studies were of opinion that success rate in well/fairly controlled diabetics was either equal or insignificantly lower than normal individuals(13).

While other study, prospective in nature, observed significantly high early failures with probable reason that placement of multiple adjoining implants in diabetic patients increased the failure rates due to large wound, delayed healing and greater force posed over implants.

Inadequate time (study period 90 days only) provided for osseointegration and regaining stability to implant in the study seems to be the cause of observing very high failure in diabetic patients.

Possibility of dental implants for diabetics: Diabetes are a special category that require more measures and precautions when undergoing any surgical intervention, especially in the event of dental implant surgery.

In order to ensure that dental implants can be implanted for diabetics without them being damaged again, the patient needs to perform a test for the cumulative sugar level for dental implants to determine the level of glucose in the blood(96).

If the result of the test matches the normal levels, then there is no problem with performing the implant, but if the blood sugar level rises It is necessary to consult an internal medicine and endocrinologist first to control the blood sugar level, and then perform the operation(55).

After dental implants for diabetics:

After a diabetic patient undergoes dental implant surgery, he must follow several instructions, the most important of which is to review the doctor periodically to check the implants and their condition, in addition to staying away from all factors and influences that disturb blood glucose levels, in order to prevent exposure to damage from the implant(12).

Chronically high levels of plasma glycaemia lead to the onset of chronic vascular complications of this condition, a frequent cause of morbidity and mortality in these patients (Figure 1). The treatment of diabetes aims at achieving optimal metabolic control so as to avoid or delay these complications (3).

Over the last few years, special importance has been given to the relationship between diabetes and oral pathologies. Periodontal disease, frequently co-existing with diabetes, is considered to be a further complication of this disease. It affects both patients with type 1 and type 2 diabetes mellitus, and it increases the risk of severe periodontitis by a factor of 3 to 4 times (4).

Inclusion and Exclusion Criteria

Clinical human studies were included, with information on implant failure rates in diabetic and non-diabetic individuals rehabilitated with cylindrical modern dental implants of commercially pure titanium or its alloys. As an individual is either diabetic or not, it is impossible to randomize the placement of implants for this condition(75).

Therefore, non-randomized and retrospective clinical studies were also considered for inclusion in the present review(69).

Only studies including diabetic patients under glycemic control were included. This information, when not available in the publications, was obtained by contact with the authors of the articles(81).

Case reports, technical reports, animal and in vitro studies, and review papers were excluded. Studies evaluating mini-implants, zygomatic, orthodontic, zirconia, subperiosteal, or hollow implants were excluded(55).

Harmful effects of dental implants for diabetics:

One of the most common harms that diabetic patients may be exposed to after various surgical interventions is the difficulty in healing the wound, which may expose the patient to many complications, including tissue damage at the site of surgery as a result of insufficient blood supply to it, or severe inflammation of the gums that may effect On the results of the operation.

Therefore - as we mentioned - you must first ensure that your blood sugar level is maintained normal before undergoing any surgery. In conclusion, dental implants appear as an excellent option for diabetics who suffer from dental problems as a result of high blood sugar levels(76).

Despite the challenges that dental implants may face in diabetic patients, many studies and clinical trials indicate the success and effectiveness of this procedure in these patients. It is important to contact a specialist dentist to accurately evaluate the condition and determine whether dental implants are the appropriate solution, in addition to following the necessary oral and dental care tips after the operation to ensure its success and maintain the general health of the mouth and teeth(23).

* Performing dental implant surgery for diabetic patients under strict conditions.

* It is necessary to control the blood sugar level before performing a dental implant procedure

* Uncontrolled blood sugar levels affect the osseointegration of dental implants "My teeth have begun to fall out due to diabetes, and I know that any surgery will pose a threat to my life. I have come close to losing hope in dental implants(47).

Concerns and questions run through the minds of many people with diabetes.

Because this disease has a negative impact on the health of the mouth and teeth, and many diabetic patients suffer from loose teeth and then their loss many times, which makes them need to have replacement teeth installed, thus beginning the usual declared war between diabetes and performing any surgical operation, which is the greatest challenge.

What any medical team faces in light of the risks of non-healing of the patient's wounds. Despite this major obstacle, it must be remembered that diabetes and many other chronic diseases are not a definite contraindication for dental implant surgery.

However, they are considered among the special cases that require the application of controls and conditions determined by the dental implant specialist in cooperation with the endocrinologist to perform this operation. In medical scientific language, it can be said that after a dental implant operation, lack of discipline in blood sugar levels affects the osseointegration of the implant and the continued success of the operation for long periods(102).

This is what the patient must understand and appreciate when the doctor refrains from performing the procedure before obtaining special examinations. The patient should not even be fidgety when the dental implant specialist asks to bring a report from the endocrinologist supervising the case.

Because the risk of dental implants for diabetic patients is represented by two main points, the first of which is the slow healing of wounds and bone after dental implant surgery compared to people without the disease, and the second is that a diabetic patient has a greater possibility of swelling of the gums or infection after dental implant surgery(90).

Because my first priority as a doctor is the patient's general health before talking about the importance of implants, especially thought of the transformation of some dental implant operations - unfortunately - into a commodity whose goal is to make money, regardless of the state of health references, I confirm that the operation can be performed, but under strict and clear conditions among them. :

Close and continuous follow-up with the specialist doctor to control the blood sugar level within its normal levels while taking medication, in addition to performing the necessary medical tests before dental implants, most notably the analysis of normal blood sugar and cumulative blood sugar, which shows the extent of the patient's sugar level during the last six months. The patient must know that if his blood sugar is irregular or high, it means that he must wait perhaps months until his blood sugar level is controlled before dental implants.

Effect of diabetes on bone and osteointegration

The persistent hyperglycemia in diabetic individuals, inhibit osteoblastic activity and alters the response of parathyroid hormone that regulates metabolism of Ca and P,[10] decreases collagen formation during callus formation,(11) induces apoptosis in lining cells of bone(12) and increases osteoclastic activity(13,14) due to persistent inflammatory response. It also induces deleterious effect on bone matrix and diminishes growth and accumulation of extracellular matrix.(15) The consequent result is diminished bone formation during healing, which is observed in number of experimental animal studies.(16,17,18,19).

Diabetes causes decreased bone mineral density, as well as reduced bone formation and higher bone resorption(20) whereas Type -2 diabetes produces normal or greater bone mineral density in some patients.([21) It has been observed that insulin not only reduces the deleterious effect of hyperglycemia by controlling it but also stimulates osteoblastic activity. Hence, bone matrix formation in insulin treated experimental models is similar to control ones.(22).

Table 2

Probable factors affecting survival of dental implants

Factors associated with diabetes	Rehabilitative factors
Type of diabetes Diabetes duration	Type of restoration Fixed/removable Long span/short span
Diabetic condition i.e., level of diabetes control reflected through HbAc1 level	Implant location Maxillary/mandibular
Status of diabetic complication i.e., micro- and/or macro-angiopathy-absent/mild/moderate/severe	Anterior/posterior Implant length Bone type and quality
Method of controlling hyperglycemia-through dietary control/oral hypoglycemic/insulin administration	Surgical protocols Surgical complexity Duration for osteointegration before second surgery and functional loading

CONCLUSION

The survival of dental implant in well/fairly controlled diabetic patients appears as good as in general population(80).

Use of prophylactic antibiotic, longer duration of post surgical antibiotic course, chlorhexidine mouth rinse, bioactive material coated implants and implant with higher width and length seems to further improve the survival of implant in diabetic individuals(76).

Systemic administration of some insulin sensitive adipokine and use of local growth factors have been found to improve osseointegration in diabetic experimental animals but yet to be verified in human beings(40).

However, it is advisable to delay the placement of implant in poorly controlled diabetics till the control of diabetes(54).

Longer duration prospective clinical studies with greater number of diabetic individuals and non-diabetic controls are still required to develop better understanding of impact of diabetes over dental implant success.

3.5. Meta-Regressions:

Information on the (mean) follow-up time was available in 72 publications, while no precise information on follow-up (for example, life-table or Kaplan–Meier analysis) was available for the remaining 17 studies(77).

In a meta-regression including these 72 studies, it was observed that the follow-up time had an effect on the OR of implant failure between the groups (Figure 7), resulting in the following linear equation:

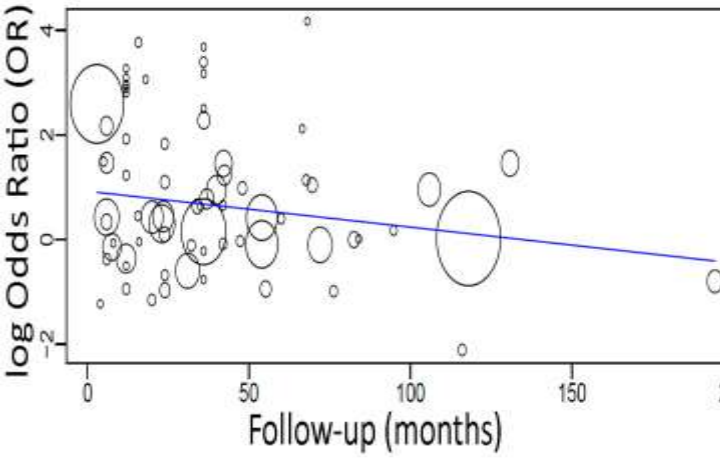

Figure (7)

Scatter plot for the meta-regression with the association between the odds ratio (OR) of implant failure between diabetic and non-diabetic individuals, and the follow-up time (in months). Every circle represents a study and the size of the circle represents the weight of the study in the analysis(63).

y = 0.922 − 0.007x, where:

Intercept = 0.922 (0.515, 1.329), standard error 0.208, $p < 0.001$

Follow-up = −0.007 (−0.014, 0.000), standard error 0.003, $p = 0.048$

There was an estimated decrease of 0.007 in OR for every additional month of follow-up, with statistical significance.

A sensitivity analysis of the meta-regression plotting together only the studies with follow-up up until 5 years (Figure 8) resulted in the following linear equation:

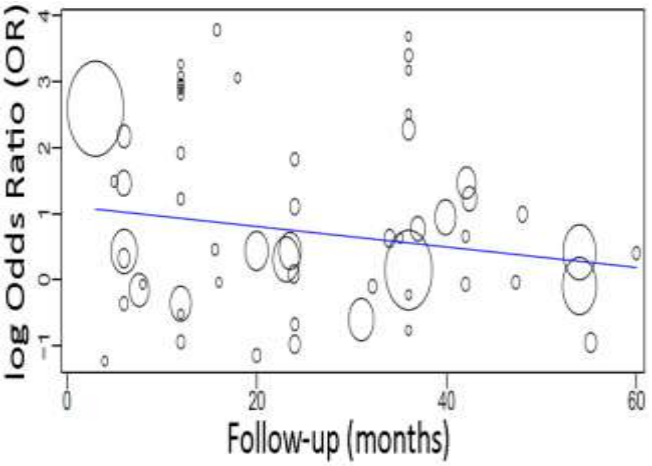

Figure (8)

Scatter plot for the meta-regression with the association between the odds ratio (OR) of implant failure between diabetic and non-diabetic individuals, and the follow-up time (in months; limited to 60 months). Every circle represents a study and the size of the circle represents the weight of the study in the analysis(49).

y = 1.117 − 0.015x, where:

Intercept = 1.117 (0.529, 1.705), standard error 0.300, $p < 0.001$

Follow-up = −0.015 (−0.034, 0.003), standard error 0.010, $p = 0.105$

In this case, there was an estimated decrease of 0.015 in OR for every additional month of follow-up, although not statistically significant.

A meta-regression considering the effect of follow-up on MBL mean difference between groups (Figure 9) resulted in the following first-degree equation:

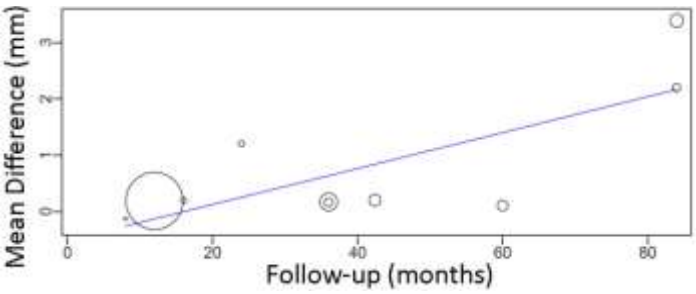

Figure (9)

Scatter plot for the meta-regression with the association between follow-up (in months) and MBL mean difference between diabetic and non-diabetic individuals. Every circle represents a study and the size of the circle represents the weight of the study in the analysis(70).

y = −0.510 + 0.032x, where:

Intercept = −0.510 (−1.320, 0.301), standard error 0.414, p = 0.218

Follow-up = 0.032 (0.015, 0.049), standard error 0.009, p < 0.001

There was an estimated increase of 0.032 mm in the mean difference of MBL between groups for every additional month of follow-up, with statistical significance(43).

3.6. Publication Bias

The funnel plot did not show a clear asymmetry (Figure 10), indicating a possible absence of publication bias.

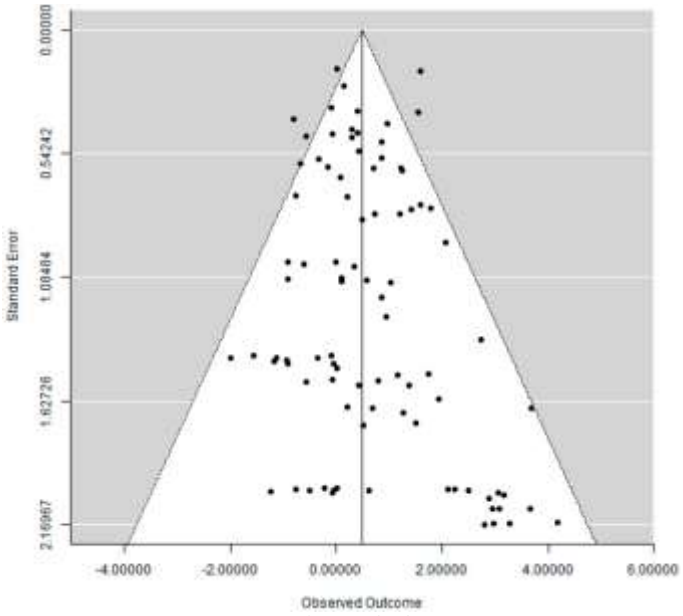

Figure (10)

Results:

Records from 782 patients who had received dental implant treatment were identified. Of these 782 patients, 25 (3.2%) were diabetic before installation of dental implants. The median age of the diabetic patients was 63 years, ranging from 47 to 79 years. The frequency of insulin-dependent diabetes (type 1) and noninsulin-dependent diabetes (type 2) was 36% and 64%, respectively. Among the diabetic patients, 20% were smokers(51).

Discussion:

The aim of the present systematic review was to compare the clinical outcomes of dental implants between diabetic and non-diabetic patients.

This is not the first review on the subject. However, previous reviews either failed to conduct any statistical analysis [23] or were based on much fewer clinical studies (14,24,25).

The present review adds much more data (from 89 studies) for the analyses and is the first one in many aspects: (a) to perform a sub-analysis comparing dental implant failure rates between type 1 and type 2 diabetic patients; (b) to perform subgroup analyses for implant failure when only studies evaluating implants inserted in maxillae, as well as when only studies evaluating implants inserted in mandibles; (c) to perform a meta-regression testing the association between the odds ratio of implant failure between diabetic and non-diabetic individuals, and the follow-up time; (d) to perform a meta-analysis on the difference of MBL between diabetic and non-diabetic patients; and (e) to perform a meta-regression testing the association between follow-up and the MBL mean difference between diabetic and non-diabetic individuals(16).

In conclusion, implants placed in diabetic patients present a statistically significant higher risk of failure and greater marginal bone loss than implants placed in non-diabetic patients. When it comes to the comparison between different types of diabetes mellitus, implants placed in diabetic type I patients present a much higher risk of failure than implants placed in diabetic type II patients(92).

Most of the experimental studies have been indicated that the bone matrix formation and bone mineralization was almost equal in controlled diabetic and non-diabetic animals but BIC was lower even in controlled diabetic subjects. Number of studies has proposed and explained mechanism of deleterious effect of diabetes over wound healing and true association (osseointegration) of bone to implant surface [Figures [Figures11 and and2(.2). However studies,[31,32] performed in humans specifically with diabetes type-2, observed insignificant effect over BIC and consequently good osseointegration of dental implant in controlled diabetic patients. As most of the experimental studies conducted in rats and rabbits, the architectural and compositional difference in bone, higher metabolic rate, very permissive bone healing, faster skeletal changes and bone turnover(58,59) may be the reason for the difference in results of experimental animals and humans.

The difference in developing diabetes (alloxan or streptozotocin destruct beta cells of Langerhans consequently induces diabetes) in experimental animals and human being (type-2 diabetes develop due to glucose resistance at cellular level and higher level of glucose in tissue consequently suppress the function of beta cells of Langerhans in long duration) maybe one reason for the difference in BIC.

The result of an experimental study in obese diabetic rat strengthens the above explanation, as no difference in BIC was observed in obese diabetic rat than normal one.(60)

Conclusions:

There is evidence that hyperglycaemia has a negative influence on bone formation and remodelling and reduces osseointegration of implants. Soft tissue is also affected by the microvascular complications deriving from hyperglycaemia, vascularization of the tissue is compromised, healing is delayed and wounds are more predisposed to infection(61).

This entails an increase in the percentage of failures in the implant treatment of diabetic patients(53).

The bibliography reviewed recommends good glycaemic control in the peri-operative period in order to improve the survival rates for implants in diabetics(87). HbA1c figures of less than 7% indicate appropriate glycaemia levels in the preceding 6 8 weeks. Pre-operative antibiotic therapy and the use of 0.12% chlorhexidine mouthwash are recommended as both measures have been shown to reduce the percentage of failures(51).

Although there is a higher risk of failure in diabetic patients, experimental studies have shown that the optimization of glycaemic control improves the degree of osseointegration in the implants. Nonetheless, it is necessary to extend the number of prospective studies in humans in order to clarify the true impact of diabetes on the prognosis for osseintegration(66).

Today, diabetic patients are being successfully treated for all types of edentulism, including bone-grafting treatment. Diabetics that undergo dental implant treatment do not encounter a higher failure rate than the normal population if the patients' plasma glucose level is normal or close to normal as assessed by personal interviews(33).

In conclusion, implants placed in diabetic patients present a statistically significant higher risk of failure and greater marginal bone loss than implants placed in non-diabetic patients. When it comes to the comparison between different types of diabetes mellitus, implants placed in diabetic type I patients present a much higher risk of failure than implants placed in diabetic type II patients(42).

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