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Literature Review

Effect of Glycaemic Control on Dental Implant Stabilisation in Diabetic Patients: A Literature Review

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Abstract

Background: Diabetes mellitus adversely affects wound healing and increases susceptibility to infections, both of which can compromise the success of dental implants. Glycated hemoglobin (HbA1c), as an indicator of glycemic control, plays a key role in the healing process and Osseo integration. Poorly controlled diabetes is associated with delayed bone healing and impaired implant stability.

Objective: To understand the relation of implant stability in diabetic patients.

Materials and Methods: A systematic search was conducted using electronic databases and hand searching relevant journals. Studies included were clinical trials, cohort studies, and systematic reviews published in the last 10 years. Non-clinical studies or those outside the defined period were excluded. Data were extracted on implant success rates, implant stability quotient (ISQ) scores, and marginal bone loss (MBL) in both diabetic and non-diabetic patients. A total of 101 articles were identified; after screening, 56 were eligible, and 25 were included in the final review.

Results: Primary implant stability, as measured by ISQ values, did not show significant differences between diabetic and non-diabetic patients. Reported implant success rates ranged from 85.6% to 98.6% over 1 - 2 years. However, diabetic patients exhibited slightly higher MBL compared to non-diabetics. The degree of glycemic control, reflected in HbA1c levels, was consistently linked to implant outcomes. Well-controlled diabetes did not appear to compromise implant stability or success, while poor glycemic control increased the risk of complications.

Conclusion: Management of blood glucose levels is paramount for enhancing implant success rates and minimizing complications in diabetic individuals undergoing implant treatment.

Keyword: *Glycaemic Control; Osseo Integration; Hyperglycaemia; Marginal Bone Loss; Implant Survival Rate*

Abbreviations

AGEs: Advanced Glycation End Products; BIC: Bone to Implant Contact; HbA1C: Glycated Hemoglobin; ISQ: Implant Stability Quotient; MBL: Marginal Bone Loss; NDIS: Narrow-Diameter Dental Implants; NM: Nano-Modified; PIBL: Peri-Implant Bone Loss; RFA: Resonant Frequency Analysis; SMs: Safe-Multifunctional-Solid; T2DM: Type 2 Diabetes Mellitus

Introduction

Tooth replacement using dental implants has become a popular approach in reconstructive dentistry in terms of functionality and aesthetic compensation identical to healthy dentition. The history of the present dental implant ology begins at the dawn of the 19th century [1,2]. Nevertheless, evidence has shown that implant therapy in T2DM yields success rates different from non-diabetic patients owing to the metabolic changes linked with diabetes [3]. The International Diabetes Association approximates global diabetic adult totals at over 460 million, arguing for increased implant studies related to glycaemic control patient [4].

T2DM which has been defined by insulin resistance and relative insulin deficiency, results in constant high glucose levels or hyperglycaemia which has a significant impact on wound healing and bone metabolism [5]. AGEs formed together with increased oxidative stress observed in diabetic patients cause chronic inflammation altering normal bone remodelling and may potentially affect Osseo integration. Literatures have established that diabetes patients exhibit less bone mass mineralization and higher risk of fractures than non-diabetic subjects [6].

Osseo integration critical for implant stability is a cellular phenomenon that includes biological events such as osteoblasts' chemotaxis, neovascularization and new bone formation [7]. These changes in the cellular signalling impairs revascularization around the implant surface and the bone-implant interface which is contributed by hyperglycaemia [8].

Some evidence is available to suggest that glycaemic control measured by glycated haemoglobin, HbA1c is a core factor influencing bone healing and consequently implant outcomes. As better diabetic control through diet medication and co-interventions are conceived to directly benefit Osseo integration by preventing diabetic ally induced disruptions to the processes of bone healing further to aetiopathogenic effects, the agnostic relationship between glycaemic control and implant outcomes continues to be investigated by others [9].

Subsequent systematic reviews have underlined the interrelation between periodontal status, glycaemic index and implant survivability [10]. Periodontal treatment has been proved effective for modifying glycaemic control of type 2 diabetes mellitus and signifying the significant and mutual interaction between oral health and diabetes [11,12]. These result imply that simultaneous management by both dentists and physicians may be essential for achieving the best appliance results in T2DM subjects [13-15].

Since dental implant therapy is being delivered more frequently to T2DM patients understanding the association between glycaemic control parameters and implant stability is of high practical value [16-18].

The relationship between diabetes mellitus and implant failure rates has been the subject of controversy among previous researchers. This review seeks to review latest clinical literature regarding the available treatment options and risk estimation based on glycaemic control as indicated by HbA1c levels for planning dental implant therapy in T2DM patients.

In compiling the available literature This literature review will endeavour to lay a comparison of the results of various studies concerned with the effect of glycaemic control on dental implant stabilization in type DM patients.

Impact of glycaemic control on implant stability

A growing area of interest over the last few years is the correlation between glycaemic control and implant stability in diabetic patient. Clinicians should pay attention to these HbA1c levels when managing its patients for treatment and post-operative care to make sure that any possible implant failure is kept to minimum.

It is well documented that sustained raised blood glucose levels raise the risk of pre implant diseases, especially in the context of NDIs This imply that when patient have poor glycaemic control then the long term success of dental implants may be threatened especially when the size of the implants is constrained [19]. Also, it has been pointed out that poor glycaemic control is directly related to higher complication rates as well as to implant on crestal bone and probing depth around implants and also affect implant stability [20]. On the other hand Oates., *et al*. demonstrated that HbA1c had no effect on implant performance where the implant survival one year after loading was compared. However, implant stability was found delayed directly with poor glycaemic control of the patients again underlining a significant correlation. This suggest that in the management of overall survival rates may not be compromised but that the process of Osseo integration could be retarded in poorly controlled diabetics [21].

Additionally, lesser levels of bone-related growth factors have been detected in poorly controlled diabetic patients than normal systematic health. This raises the possibility that instability of glucose regulation might undermine the molecular processes of Osseo integration and thus the implant's stability and overall success [22]. Nonetheless, implant success can be achieved in a diabetic patient, and maintaining the highest HbA1c value appears to be critical to achieving the best prognosis and avoiding related issues.

Osseo integration and implant stability in diabetic patients

The effect of diabetes mellitus on Osseo integration and implant stability are widely discussed in research and the patterns are rather contradictory and multifaceted. The authors analysed recent literature data to conclude that although diabetes affects implant the extent of its impact depends on glycaemic control and diabetes type.

Implants retained in diabetic patients did not show poor prognosis. Rather, the true of potential implant failure It has been found from various researches that premature marginal bone loss (MBL) is higher amongst the diabetic patients as compared to the non-diabetic patients. A higher percentage of peri-implant bone loss in diabetic patients was reported [23]. Providing valuable data for the evaluation of changes in the PIBL of well-controlled and poorly controlled T2DM patients significant differences in RFA values were observed at baseline and at the 3-month follow-up period in poorly controlled T2DM patients, which may be a sign of the deleterious effects of insufficient glycaemic control on early implant stability, a clear correlation between glycaemic control and the amount of peri-implant bone that was lost [24]. The average MBL considerably differed between the moderately and poorly controlled diabetic groups measurements [25].

High to promote result with one hundred % survival and success rated recorded in both T2DM and control group participants after two years of follow up. The study did not show any significant variations in marginal bone loss (MBL) between T2DM and control groups suggesting that controlled type 2 diabetes mellitus may not be a direct influence to peri-implant bone resorption as hypothesized [26]. Likewise, Ibraheem EM (2016) found similar results regarding the immediate and delayed loading protocols for well-controlled diabetics [27].

RFA measurements when Implant stability, glycated haemoglobin (Hb1Ac) levels and time post implantation were analysed. Poorly controlled diabetes patients showed the largest mean loss of implant stability ($P < 0.001$) Overall time needed for the implants to achieve the baseline stability was directly related to the hyperglycaemic condition in the study. However, those with poor glycaemic control required nearly twice the time to reach the standard Implant Stability Quotient as those without diabetes [28].

According to the work of Cabrera-Domínguez., *et al*. in 2021, proof was established with 100% survival and success rates concluded in the T2DM and control group after two years of treatment. This study obviously did not find significant difference in the amount of marginal bone loss (MBL) in the T2DM compared to the control group and evidence from this confirms the hypothesis that perhaps well managed T2DM does not invariably result in higher peri-implant bone resorption rates [29].

The basic surgical techniques research comparing Cristal bone loss using intraoral periapical radiograph and computers software revealed that there was no significant difference in mean mesial or distal Cristal bone loss between flap and flapless implant placement techniques at T2DM patients in both 6 and 12-month post implant placement [30].

While the survival rates are equal, the Sam L's 2020 study introduced BIC differences into T2DM and healthy persons. original Implants, T2DM patients had a significantly lower BIC percentage (30.73%) as opposed to controls (41.75%) which implies that even for participants with T2DM in optimal glycaemic control, the initial bone to implant contact is impaired. New bone formation around the implant was also lower in T2DM patients (36.25%) compared to controls (44.14%) meaning unfavourable effects on the bone regeneration and remodel process [31].

The impact of the disease on bone metabolism has been identified to be negative in some way. the stability of the dental implant regarding its long time durability in diabetic patients. The study found that implants placed in diabetics have poor outcome are 1.46 times more likely to fail and have 0.8 mm higher marginal bone loss compared to non-diabetics. Type I diabetic patients show two-fold higher implant failure rates compared to the patients with Type II diabetes. These results clearly demonstrate that more attention should be paid to diabetes type and glycaemic control when implant therapy is being designed [32].

Implant survival and success rates

Survival rate for dental implant interventions specifically for the T2DM patients has been generally observed to be very high. The success rate over one year was 100% across normoglycemic, well-controlled T2DM and poorly controlled T2DM patients. Although early bone healing and implant stability might be affected by hyperglycaemia one-year overall survival was still significantly favorable (non-diabetic: 99.0% and well-controlled T2DM: 98.9%, poorly-controlled T2DM: 100%). Even when justified based on attrition through loss to follow-up these high survival rates defended themselves with minimal intergroup differences [33,34].

Chae., *et al*. also found a 94% implant survival rate in diabetic patients with HbA1c levels up to 8% over a mean follow-up of 8.7 years did not record a significant difference in implant survival rates of fairly well controlled and well controlled diabetic patients after six years (98.0% and 98.8%) respectively What this indicated was that simple glycemic control might be enough for deep-implant success, which questioned the value of stringent glycemic control all the time [35].

The idea that Osseo integrated dental implants can be implanted successfully in both well-controlled and poorly controlled diabetic individuals. Thus, recipients with type 2 diabetes have similar implant survival rates as non-diabetic subjects however proper glycaemic control is mandatory to enhance Osseo integration and achieve the best prognosis of treatment [36-38].

Implant stability quotient (ISQ) and bone-related factors

Implant stability is one of the determinants of dental rehabilitation, especially in patients with type 2 diabetes mellitus. Kasiroumpa., *et al*. 2022 did not observe the effect of diabetes on any changes in ISQ values before and four months after implant placement. This led to the idea that the effect of diabetes may not be severe regarding the primary implant stability or early stage of Osseo integration. However, Sandra G in his review done on 2019 stated that on the one and 3 months of implanting, non-diabetic patients experienced higher percentage increase in ISQ 14.2% than diabetic patients 6.03%. This implies that diabetes might also impact on the extent of implant stability gain during the initial healing period [32,39].

A histomorphometric assessment of Osseo integration between maxillary dental implant patients T2DM with good glycaemic control and healthy patients was also carried out. The study also showed that both groups had normal bone healing rates as displayed by the two graphs. For the long-term implant stability, the implant stability quotient (ISQ) was assessed at one-year follow up and found both the T2DM (81.03 ± 0.68) and control (81.66 ± 0.67) group showing non-significant difference for the long term implant stability. Surprisingly, ISQ was not correlated with BIC, and new bone formation and there was no additional evidence of new bone formation ($p > 0.05$). However, the findings of the present study showed that poor glycaemic control leads to a reduction of BIC and overall Osseo integration [40].

Implant technologies

Recent improvement in implantation advancement has therefore sought to unveiled challenges associated with dental implant placement on patients with type two diabetes mellitus. Thus, while a variety of SMs has been addressed, it can be concluded that implant Osseo integration appears comparable among different implant types in T2DM patients: NM titanium implants are promising to have some advantages at the stage of initial bone save interest. However, long-term osseointegration and implant success in diabetic patient do not seem to depend on the kind of implant surface, but on the general patient factors and glycemic control [41].

Conclusion

Most of the research in diabetic patient populations point to good glycaemic control of the condition as having no untoward effect on implant success, however, studies of poorly controlled diabetes show an association between the disease and increased risk of complications and marginal bone loss. Previous studies focus on achieving the best possible glycaemic control as a significant element for implant success in T2DM patients.

The literature is shown that diabetes, if well controlled might not compromise dental implant outcome in terms of success rate when compared with patients without diabetes. However, poor glycemic control is also responsible for delays in implant stabilization and Osseo integration. These findings stress the necessity for a subject-by-subject evaluation and handling of diabetic patients treated with implant therapy. However, additional prospective, long-term investigations are required to determine the effects of glycemic control on implant success in type 2 diabetes.

Ethics Approval and Consent to Participate

Not applicable.

Consent for Publication

Not applicable.

Availability of Data and Materials

Not applicable.

Conflict of Interests

Authors declared there no conflict of interest.

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