

Radiographic and clinical assessments of platform switching implant assisted mandibular overdenture in controlled diabetic patients

Original
Article

Mona M Aboelnagga , Heba Tarek Mohammad

Associate Professor at Prosthodontic Department, Faculty of Dentistry, Ain Shams university, Cairo, Egypt .

ABSTRACT

Background: Currently platform switching concept is widely used in implant dentistry; however, its influence on the health of surrounding soft tissue and marginal bone level alterations in implant assisted overdentures and especially in controlled diabetic patients, remains inconclusive.

Objective: The purpose of this research was to assess the viability of platform-switched implants for improvement of osseous and soft tissue response in implant-assisted mandibular overdentures in completely edentulous controlled diabetic patients having type 2 diabetes mellitus (T2DM) and compare it with non diabetic patients as control group.

Material and method: Fourteen completely edentulous patients were included in this study, two groups were formed; Group I patients who are non diabetic (as control group) and group II patients medically diagnosed T2DM and controlled. New upper and lower complete dentures were constructed following the conventional steps. For all participants, two platform-switching implants were inserted in the mandibular canine area following flapless technique guided by 3D printed surgical guide constructed according to the planned CBCT data evaluation. Immediate loading protocol was applied as pick up of the metal housing of the attachment was done in the day of implant placement. Gingival index and pocket depth were measured at one week after implant placement, 3, 6 and 12 months follow-up. While peri-implant marginal bone level was measured at loading time, 6 and 12 months follow-up. For diabetic patients (group II) hemoglobin A1c test was done every three month for monitoring their medical condition. Data collected were statistically analyzed.

Results: Peri-implant bone loss of higher values was found in diabetic patients (group II) compared to non diabetic patients (group I) but with no statistical significance along the study period follow up records. Peri-implant gingival index and pocket depth showed no statistical significance along the study period with better value for non diabetic patients compared to diabetic patients.

Conclusions: Within the limitations of this study, it was revealed that using two platform switching implants in assisting mandibular overdenture is a successful and predictable treatment option for type2 controlled diabetic patients as non diabetic patients. Peri-implant bone loss was found in type2 controlled diabetic patients higher but insignificantly when compared to non diabetic patients during one year follow up period. Regarding the clinical assessment there was no significant difference in both groups with consideration of continuous glycemic control and optimum oral hygiene measures.

Key Words: Platform switching, implant-assisted overdenture, type 2 diabetes mellitus, peri-implant parameters, marginal bone level.

Received: 27 May 2022, **Accepted:** 4 June 2022.

Corresponding Author: Mona M Aboelnagga, Associate Professor at Prosthodontic Department, Faculty of Dentistry, Ain Shams university, Cairo, Egypt , **Tel :** 26710385, **Mobile:** 01114401177, **E-mail:** maboelnagga@gmail.com

ISSN: 2090-097X, January 2022, Vol. 13, No. 1

INTRODUCTION

Dental implant treatment has been proven as an anticipated treatment option, with high success and survival percentages in short and long-term applications ^[1,2]. Management of completely edentulous mandibular arch with an implant assisted overdenture by placing two dental implants in the interforaminal is the most common prosthetic treatment options ^[3].

The success of dental implants is directed via several considerations, most essentially, bone quality and quantity. The implant surface characteristics have an effect on the biological responses arising at tissues-implant interface. Furthermore,

implant design and implant-abutment connection have been recognized to have affect osseointegration ^[3].

Platform switching approach was found to regulate marginal bone loss following insertion where implant-abutment junction is located closer to the center of the implant ^[4]. This concept is based on the placement of abutment of smaller size diameter than that of the implant diameter, repositioning the micro-gap between implant and abutment toward the center of implant and distant from the surrounding bone. This was reported to improve the stress distribution and have a direct influence on crestal bone level changes where decreases the peri-implant bone loss in the first year ^[5]. The concept of platform switching has enhanced the development of biologic width. The

inward placement of the implant-abutment interface that creates an additional horizontal surface area thus permitting the biologic width to be formed horizontally and reducing the amount of crestal bone resorption. This appears around implants following uncovering, the development of a biologic width takes place thus it surrounds itself with periosteum and connective tissue^[6].

Relocating of the implant-abutment interface inward and further than the outer surface of dental implant and the nearby bone decreases the abutment inflammatory cell effect on adjacent tissues, thus reducing its resorptive effect on the surrounding marginal bone^[7, 8].

Implant survival is an evidently well-defined and assessed end-point for dental implant rehabilitation.

Implant survival is primarily reliant on successful osseointegration subsequent its insertion. Any change of this biological development may unfavorably affect the treatment consequences. Diabetes mellitus is chronic metabolic disorder which results in hyperglycemia, that leads to several complications produced by micro and macro-angiopathy^[9]. Diabetic patients have high prevalence of periodontitis and subsequent tooth loss, belated wound healing and compromised response to infection^[10, 11].

In the past diabetes mellitus has been recognized as relative contraindication for dental implant procedures due to the microvascular complications that may affect post surgery healing process and make it slower and increased proneness to infection^[12, 13]. However nowadays, understanding the conditions that makes the patient at a greater hazard of complications will permit the practitioner to sort well-versed decisions and adjust the treatment plan to enhance the consequences^[14].

Well-controlled diabetic patients can be determined as suitable candidates for implant rehabilitation, while patients who are missing good glycemic control might be deprived of the benefits of implants treatment options^[15]. Though the prospective benefits of implant prosthesis as providing support and enhancing retention and stability of the denture thus increasing patients satisfaction can be significant for diabetic patients taking into consideration that their plasma glucose levels is under metabolic control^[16]. Many studies have stated that chronic hyperglycemia (CH) in patients having inadequately controlled diabetes mellitus is major risk factor leading to inflammations of the soft tissues and marginal bone loss surrounding the osseointegrated implants and teeth. A justification for that, the CH is accompanied with higher formation and accumulation of advanced glycation end-products in the systemic and oral tissues that rise the release of pro-inflammatory cytokines that increase crestal bone loss if kept uncontrolled^[15, 17-19]. Nevertheless, under optimum glycemic control, dental implants can make successful osseointegration and persist functionally stable for long periods in diabetic patients in an approach like non-diabetic individuals^[20, 21].

The HbA1c is a precise and easy to administer test with immediate results accessibility and can be an efficient tool in the diagnosis of diabetes. HbA1c (glycosylated hemoglobin) can reveal glucose levels in blood throughout the preceding 6–12 weeks previous to the test. It is stated as a percentage of the total hemoglobin. For an HbA1c test to categorize as normal, or non-diabetic, the value should be less than 5.7%. If the value is ranging 5.7% to 6.4% the individual is considered to be prediabetic, while diabetes patient can be diagnosed with a value HbA1c of 6.5% or more. The HbA1c allows evaluation of intermediate term balance of diabetes, therefore the practicality of implant-supported rehabilitation should be evaluated with the previous test results^[13, 22].

Evaluation of peri-implant tissue health is very essential for recognition of early signs of peri-implant diseases. It was shown evidence that formation and growth of a microbial biofilm is a significant etiologic factor in the pathogenesis of peri-implantitis and consequent marginal bone loss^[23]. Subsequent to plaque aggregation on implant surface, it spreads apically though clinical and radiographic symptoms of tissues damage will be detectable. Thus keeping oral hygiene and elimination of plaque nearby the implants are very essential in preservation of the tissues around the dental implant^[24]. Currently platform switching concept is widely used in implant dentistry; however, its influence on the health of surrounding soft tissue and marginal bone level alterations in implant retained overdentures and especially in controlled diabetic patients, remains inconclusive. Thus the current study aimed to test the hypothesis that there is an equivalent status for the health of surrounding soft tissue and marginal bone level around platform-switching implant abutments in mandibular overdentures in controlled diabetic patients; type 2 diabetes mellitus (T2DM) and non-diabetic patients as control group.

MATERIALS AND METHODS

For this study, fourteen completely edentulous patients were selected from out-patient clinic, prosthodontic department, Faculty of Dentistry, Ain Shams University. The inclusion criteria were patients with age range 50-65 years, seven patients with controlled type 2 diabetes mellitus and seven patients systemically healthy non-diabetic. All patients had their medical records to confirm their medical status including the glycosylated hemoglobin test (HbA1c test) to confirm that all selected participants in group I (healthy non diabetic) its value is less than 5.7% while those in group II were controlled having levels ranging 6.5 up to 7%.

Patients whose HbA1c levels were above 7% were excluded from this study^[20]. In addition a questionnaire was distributed on them containing five questions about their biography and medical status. About

age, sex, for how long did he/she suffer from the diabetic condition, the last date and reading of his cumulative glucose test (indicate controlled or not), the medication taken.

Patients should be free from any additional systemic disease that might have influences on implants osseointegration and have been suffering from type2 diabetes mellitus for at least 10 years.

The mandibular residual ridge had sufficient height and width and covered by firm dense fibrous mucoperiosteum, had Angle's class 1 maxilla-mandibular relationship and with good oral hygiene to provide the advantageous conditions for the implants. The Exclusion Criteria were patients taking medications which might affect bone metabolism, patients having parafunctional habits as bruxism and clenching and who suffered from neuromuscular disorder or formerly received radiotherapy involving the head and neck region. Patients having temporomandibular joint disorders or had their teeth extraction due to periodontal disease were also excluded from participation in this study.

Patient's approval:

All participants were informed about details of the research and objective of the study. All participants were informed about the benefits from the prosthetic treatment having a well-fitting and retentive denture. In addition they were given notice that in case of failure of the treatment modality, a conventional mandibular complete denture would be constructed as replacement.

They signed an informed consent form. All data were kept confidential; all reasonable actions to keep the security of their personal information and confidentiality of the patient protected health information were taken

Grouping of patients:

The participants were assigned into two equal groups; seven patients in each group. All patients were rehabilitated with maxillary complete denture and implant retained mandibular overdenture, receiving two platform-switched Standard (P-ST) dental implants placed in the mandibular canine region bilaterally. Where in Group I patients who are systemically healthy non diabetic (as control group) and Group II patients medically diagnosed T2DM and in controlled condition.

Patients' examination:

- Intraoral examination, visual and digital, for the mucosa covering mandibular residual ridge to confirm that it was firm, healthy and there were no signs of inflammation, infection or irritation.

- Pre-operative Cone Beam Computed Tomography (CBCT) (i-CAT FLX series Imaging Sciences

LLC, Hatfield) was taken for all participants, while their dentures in place, where gutta percha rods were put vertically on the labial flange at the area of interest (mandibular canine area) and was used as radiographic stent. Figure (1)



Figure (1): Mandibular denture with gutta percha used as radiographic guide in preoperative CBCT evaluation.

- Evaluation of diagnostic casts
 - Upper and lower alginate impressions (Cavex impression paste, cavex Holland) were made using stock trays and poured into dental stone to get upper and lower diagnostic casts.
 - A provisional centric jaw relation was recorded and the two diagnostic casts were mounted on a mean value articulator to evaluate the opposing ridge relationship and an existing restorative interarch space of minimum 12 mm to ensure the necessary space for the prosthetic components of the implant attachment system.
- Prosthetic Procedures
 - New upper and lower complete denture was constructed for all participants according to the conventional steps.
 - Virtual planning was done with dual scan protocol by modifying the duplicate of participant's lower complete denture into radiographic guide by adding spherical radiographic composite markers. The first scan was carried out for the lower denture on the cast placed on the glass table, and the second scan was done while the patient was wearing the upper and lower denture and biting in centric occlusion.
 - Based on the radiographic markers visible in both scans, the two scans were superimposed onto each other and the CBCT raw data was converted into 3D information by In2Guide cyber med software (In2Guide cyber med software, Seoul, Korea).

The Software allows rotation of the 3D images to view the proper treatment plan from all angles, to simplify the selection of the implants location in relation to the available bone, anatomical landmarks, and position of prosthetic teeth in the placed radiographic stent. Figure (2)

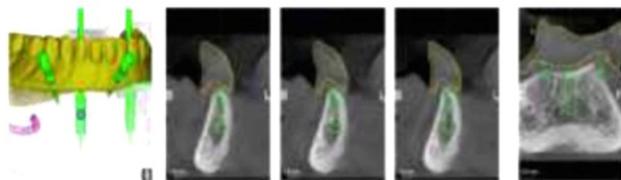


Figure (2): Planning for implant position and surgical guide.

- The mandibular CAD/CAM stereolithographic surgical guide was provided with two metallic sleeves to guide the implant placement in the virtually planned position with the precise depth, angulation, mesiodistal and buccolingual position as planned during the computer simulation. Additional three windows were added labially for fixation screws with an adequate distant from the planned implants drilling sites.

- Surgical Procedures

- Surgical Procedures was done using flapless technique and immediate implant loading protocol was followed for all participants in both groups.

- At the visit of surgery, patients of both groups were ready for the surgery following the usual protocol for implants surgery including antibiotics (Augmentin 1gm), non-steroidal anti-inflammatory drug (Ibuprofen) and chlorohexidine mouthwash were prescribed for all participants to be used one day before and four days at least after the surgical operation.

- For all participants, they were treated in the morning with short appointments, after having a normal breakfast and after taking their oral hypoglycemic agent (for diabetic patients)

- The surgical guide was disinfected according to the manufacture instruction. The patient was instructed to rinse vigorously with chlorohexidine mouthwash. Surgery was performed under local block anesthesia technique. The surgical guide was stabilized in the patient's mouth by a silicon occlusal index (Zeta Plus, putty. C-silicone impression material-zhermack company- Italy) and fixed in its place to the mandibular bone with anchor pins to prevent micro-movement that can affect the implant placement position. Fixation of the mucosa-supported surgical guide was done using the surgical kit that the manufacture provided to drill through the three labial windows to place the anchor pins. Figure (3)



Figure (3): Stereolithographic surgical guide stabilized and fixed in its place.

- The surgical occlusal index and maxillary denture were removed and the precise fit of the surgical template has been checked before starting surgery visually and manually. The osteotomy preparation was performed using the universal surgical kit supplied by the manufacture of the guide (In2Guide).

- For all patients two Platform Switching Standard (Platform Switching Standard, Multysystem CC implants, 7024209, Italy), 4.2 mm diameter and 9 mm length, tapered screw type implant P-ST, internal hex, polished treated neck with micro-throats and high frequency roughness (H.F.R) surface were placed at the pre-planned canine area. Figure (4 a)

- The drilling sequence for implants placement began with a tissue punch through each metal sleeve of the surgical guide to remove the mucosa only in those areas. The sequential drilling was done using the exact drill length and diameter according to the virtual implant plan. Then the surgical guide was removed and the platform switching implants were inserted into the prepared osteotomies and turned in a clockwise direction while applying a slight downward pressure with a torque exceeding 35 N/cm that ensures primary stability of the implants. Fig. (4 b)

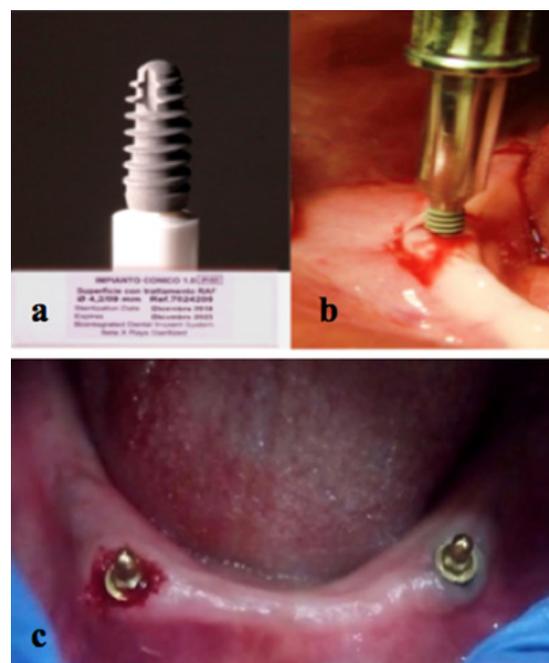


Figure (4): a) Platform switching implant, b) Implant inserted into the planned position, c) Ball abutments were screwed into the implants

- After implants insertion, primary stability of implants was confirmed using Osstell device (Osstell W&H, Göteborg, Sweden). Osstell records to be ≥ 65 to ensure the readiness of the implants to be immediately loaded with overdenture.

- Ball abutments were placed using torque not surpassing 20 N/cm. Fig. (4 c) The metal housings were placed on the ball abutment and the fitting surface of mandibular denture base opposing to the housing location was marked and relieved. Then the denture was reseated to make sure that denture was seated securely over the mandibular ridge without any rocking.

- A direct pickup technique was followed; Plastic caps (OsteoCare Dental Implant System Ltd) were positioned on the ball attachments. Undercut of the ball abutment was covered with a small shim to stop any excess acrylic resin from entering to the undercut. Autopolymerized acrylic resin (Acrostone Cold Cure, Acrostone, Egypt) was added in the relieved areas in the fitting surface. Then the dentures were seated in patient's mouth and was instructed to close in centric occlusion until complete setting of the pickup material (for about 10 min). Afterwards the mandibular denture was removed, cleaned and any excess material was trimmed. All needed occlusal adjustments were made to remove any interferences. Figure (5 a,b)



Figure (5): a) Direct pickup while patient closing in centric. b) The metal housing picked in the fitting surface.

- All patients were given oral hygiene instructions and were informed to continue the post-surgery medications protocol. Patients in group II were stressed for the importance of continuing their diabetic medications and preserving an adequate level of metabolic control during the healing process and throughout the study period.

Patients' evaluation

- Patients in group II (T2DM) were asked to have hemoglobin A1c (HbA1c) test frequently every 3 months for monitoring their levels to ensure their medical status is under control and for post-insertion inspection and adjustments were done if needed.

- Clinical follow-up visits were scheduled at one week, 3, 6 and 12 months following implants placement for Peri-implant tissue health evaluation; gingival indices (GI) and mean probing depth while at the time of implants loading, 6 and 12 months for assessment of the peri-implant bone loss using CBCT scan.

-The Gingival Index (G.I.)

The gingival tissues around the two implants were isolated and gently dried by a piece of gauze. For each implant, the buccal and lingual surfaces were independently scored.

This was done according to the gingival scores described by Mombelli et al [25] as follows: G.I. 0: represents normal healthy gingiva, G.I. 1: represents mild gingival inflammation with slight change in color, slight edema and/or bleeding on probing, G.I. 2: represents moderate gingival inflammation with redness, glazing and bleeding on probing and G.I. 3: represents severe gingival inflammation with marginal edema and redness, ulceration and spontaneous bleeding.

-The pocket depth (P.D.)

Same observer did the records for all the participants. Williams periodontal probe was used to measure the pocket depth around each implant; as the distance between the free gingival margin and the apex of the probe. The measurements were recorded at the mid of the four surfaces; buccal, lingual, mesial and distal for each implant. The mean values of the scored surfaces for each implant were then calculated, this value was considered as the mean probing depth for that implant. Data was tabulated and statistically analyzed.

- Furthermore, any complications were recorded if present like loss of retention, loosening of the metal housing and denture fractures. Absence of complications was regarded as prosthetic success. Implant success was outlined according to the PISA consensus conference. [26]

- Radiographic evaluation

Peri-implant marginal bone loss was measured in all implant surfaces, labial, lingual, mesial and distal utilizing the linear measurement tool provided by Invivo 3D imaging software. Two horizontal lines, where one passing through the implant shoulder and the other passing through the first implant-bone contact point. Distance between these horizontal lines indicate the amount of peri-implant bone loss, it was calculated at mid of labial, lingual, mesial and distal aspects of each implant. Figure (6)

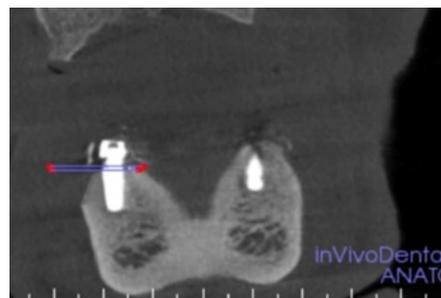


Figure (6): Two horizontal lines were drawn to assess the amount of peri-implant bone loss

Marginal bone loss (MBL) was calculated by subtracting the bone heights in the follow-up radiographs from those

in the baseline radiographs. The readings were collected, tabulated and statistically analyzed.

Statistical analysis:

Statistical analysis was performed with R statistical analysis software version 4.1.1 for Windows. Data were presented as mean difference and standard deviation. Intra and intergroup comparisons were done using unpaired t-test and student t-test respectively. The significance level was set at $P \leq 0.05$ for all tests.

RESULT

Fourteen patients (7 non diabetic, 7 controlled Type 2 diabetes mellitus) with a mean age of 60.8 years (± 4.5) fulfilling the appropriate criteria for this research were recruited into two groups. 28 implants with switched platform approach were inserted (2 in each patient) with survival rate 100% for one year follow up period.

The results of the current study are demonstrated in the following tables and figures.

1. Comparison of peri-implant bone loss (mm) in the two groups:

Unpaired t test was used to test for significance between the two groups, the mean and standard deviation was calculated. The calculated mean of the measured over all bone loss in group I was 0.24 mm and in group II was 0.32 at 6 months, in group I was 0.26 mm and in group II was 0.30 between 6- 12 months while in group I was 0.50 mm and in group II was 0.62 from loading to 12 months. Lower values of bone loss for non-diabetic patients compared to diabetic patients was found but with statistical insignificant ($P \leq 0.05$). Figure (7)

Table 1- Mean difference and standard deviation (SD) values of total bone loss (mm) in both groups

Total Bone loss in both groups					
Follow-up interval	Group I		Group II		P-value
	Mean	SD	Mean	SD	
Baseline-6 months	0.24	0.09	0.32	0.17	0.292
6 months-12 months	0.26	0.07	0.30	0.13	0.516
Baseline-12 months	0.50	0.09	0.62	0.13	0.067

*; significant ($P \leq 0.05$) ns; non-significant ($P >0.05$)

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

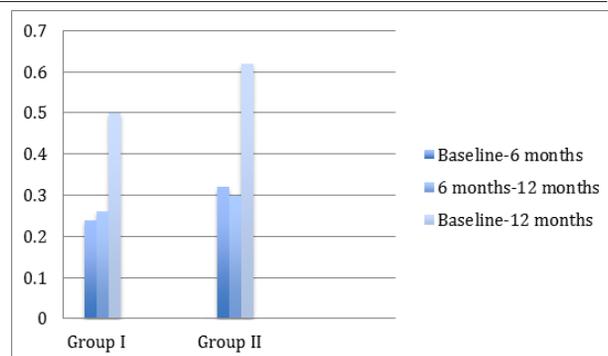


Figure (7): Peri-implant bone loss (mm) in the two groups.

2- Comparison of peri-implant tissue health parameters in the two groups:

Unpaired t test was used to test for significance between the two groups, the mean and standard deviation was calculated. At 1 week, 3 months, 9 months and 12 months, there were lower values for non-diabetic patients compared to diabetic patients but with statistical insignificant difference. The calculated mean of gingival index in group I was 0.3 and in group II was 0.4 at 1 week, in group I was 0.28 and in group II was 0.36 at 3 months, in group I was 0.25 and in group II was 0.30 at 6 months, in group I was 0.1 and in group II was 0.2 at 12 months and was found statistically insignificant ($P \leq 0.05$). Figure (8)

Table 2- Mean difference and standard deviation (SD) values of Gingival index in both groups

Follow-up interval	Group I	Group II	P value
1 week	0.30 \pm 0.70	0.40 \pm 0.48	0.56
3 months	0.28 \pm 0.42	0.36 \pm 0.32	0.32
6 months	0.25 \pm 0.32	0.30 \pm 0.42	0.80
12 months	0.10 \pm 0.32	0.20 \pm 0.42	0.62

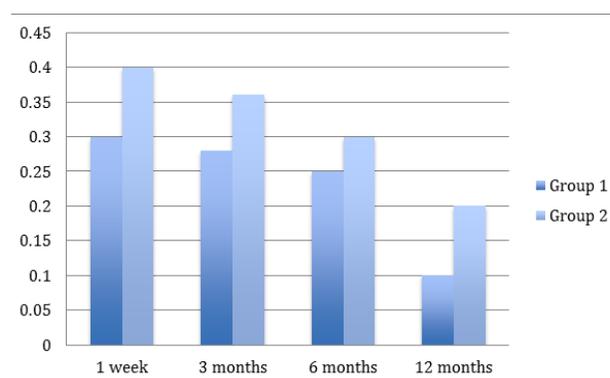


Figure (8): Gingival index in both groups

The calculated mean of probing depth in group I was 2.34 and in group II was 2.42 at 1 week, in group I was 1.98 and in group II was 2.07 at 3 months, in group I was 1.4 and in group II was 1.48 at 6 months, while in group I was 1.2 and in group II was 1.26 at 12 months and was found statistically insignificant ($P \leq 0.05$). Figure (9)

Table 3- Mean difference and standard deviation (SD) values of probing depth in both groups

	Group 1	Group 2	P value
1 week	2.34 ± 0.12	2.42 ± 0.10	0.16
3 months	1.98 ± 0.10	2.07 ± 0.10	0.11
6 months	1.4 ± 0.10	1.48 ± 0.11	0.16
12 months	1.2 ± 0.10	1.26 ± 0.13	0.28

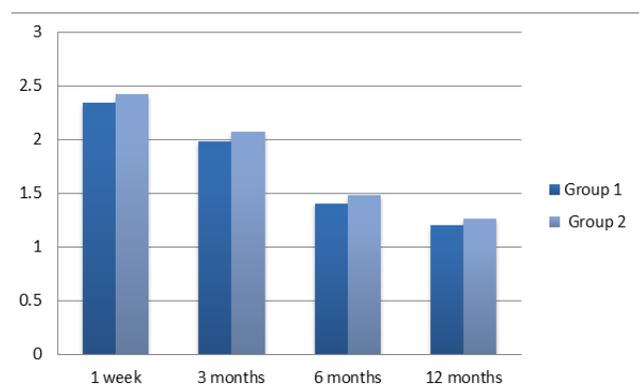


Figure (9): Probing depth in both groups

DISCUSSION

Diabetic patients who controlled their disease show less risk of various health complications than uncontrolled patients. It has been studied that well-controlled diabetics patients have good response to periodontal therapy and have fewer systemic complications than poorly controlled diabetics [27]. Thus patients were carefully selected and thoroughly examined in order to eliminate any factors, habits or debilitating diseases that might adversely influence the bone or soft tissues condition and eventually the results of this study. This was done through comprehensive medical history, clinical examination and laboratory investigation.

Guided implant placement using CAD/CAM technology was used in this study to permit the precise planning of implant locations and positioning. The guided surgery is a highly precise in implantology, it reduces the patient's chair time, the surgical procedures

become more predictable and less stressful, and the implants are placed in a driven manner through surgical guide fast and simple. Through this technique, the large amount of information acquired in a virtual planning is transferred by the manufactured stereolithography surgical guides to the surgical field [28, 29].

For diabetic patients atraumatic handling to the tissues is very essential thus flapless technique (Tissue punch protocol) was followed for both groups benefiting its advantages as maintaining the soft tissues contour, decreased bleeding at the surgical site, decreasing the postsurgical discomfort and reduce surgical and healing time [30].

Besides the minimally invasive techniques preserve the periosteum untouched; reducing the surgical trauma and maximum blood supply is maintained to the nearby bone. On the other hand, reflection of flap procedures would interfere with tissue vascularization and part of blood supply coming to bone from surrounding soft tissues is compromised [31].

Immediate loading protocol was used in this study based on other studies that used it and mentioned that there is no risk of failure [32, 33]. Where it shortens the total treatment period and permits the patients to begin utilizing their prosthesis directly after implant insertion appointment.

HbA1c values reflect the level of glycaemia control, they were made to be aware of the glycaemia control pre surgery and frequently every 3 month as a monitor for their medical status along the study period in order to be sure that the participants' status is under control [9]. Where a value of less than 7% for HbA1c is considered good level [20-34]. This assured that all participants in group II had well-controlled T2DM and maintained their glycemic levels via medications and dietary control. This helped to reduced inflammatory manifestations in the peri-implant tissues and to the stability of crestal bone around implants.

And this in addition to other factors as proper patient selection, frequent clinical and radiographic assessment, control of occlusal load, primary implant stability, maintaining good oral hygiene and patients cooperation may explain the successful results of this study as the criteria of implant success in the two groups, was revealed in the follow-up assessments that went with several studies that have shown that high implant survival rates can reach up to 100% amongst well controlled diabetic patients in a similar manner to systemically healthy non diabetic subjects; provided they have regularly maintained glycemic levels where dental implants make osseointegration and remain functionally steady [19, 35-37].

Statistical data for this study revealed that the calculated mean values of peri-implant bone loss and inflammatory response was found of insignificantly higher values for Group II (diabetic patients) compared to Group I (non diabetic patients) during all the recall appointments.

The mean amount of total bone loss detected in the studied groups was found in the normal range during the first year following implant loading. The outcomes coincide with a study proposed that vertical marginal bone loss at the peri-implant surfaces must not be more than 1-1.5 mm in the first year [38].

Peri-implant bone loss that took place in the follow up period may be caused by surgical trauma, wound healing and remodeling process. [39]

In this study, decrease in plaque accumulation was obvious due to regular oral hygiene recall appointments and that patients were following oral hygiene measures. This matches with previous studies that stated successful osseointegrated implants were in patients who performed routine oral hygiene instructions [40].

Also other study revealed that oral hygiene measures decreases peri implantitis around immediately loaded implants that were inserted in diabetic patients similar when compared to non diabetic patients [36].

A slight increase of peri implant marginal bone loss was observed during the study follow up periods in the controlled diabetic patients group but statistically insignificant, these changes coincide with the results of previous study concluding that completely edentulous type 2 diabetic patients can be rehabilitated with implant-supported prosthesis following immediate loading protocol successfully provided that diabetic patients keep good glycemic control. [41]

A study shows that elevated HbA1c leads to more bone resorption after three years follow up, nevertheless this effect is not significant. Besides, the bleeding on probing is more frequently in the poorly controlled patients, but the probing depth is not increased. [20]

Peri-implant tissue health gingival indices (GI) and the probing depth (PD) were recorded. Where pocket probing depth (PD) is associated with loss of attachment and supporting bone, and this is natural during the first year. [42]

Platform switching implant maintains the height and width of crestal bone and limit the circumferential bone loss (43-45). One of the reasons that platform switching implants are recognized to preserve marginal bone from stress concentration sited at implant-abutment interface. This was also reported by other studies conducted on implant-abutment configurations [46, 47]

Moreover marginal bone being maintained in platform switching implants is attributed to a horizontally re-established biological width, where the re-positioned

bone tissues and consequently the soft tissues are in a further horizontal direction. This caused horizontal and inward shift of implant-abutment interface far from the outer edge of implant platform. [48] Furthermore, the reduced bone loss and clinical inflammatory parameters in the platform switching implant might be the result of inward shift of inflammatory cell away from surrounding crestal bone [49]

CONCLUSION

Within the limitations of this study, it was revealed that using two platform switching implants for assisting mandibular overdenture is a successful and predictable treatment option for type2 controlled diabetic patients as non diabetic patients.

Peri-implant bone loss was found in type2 controlled diabetic patients higher but insignificantly when compared to non diabetic patients during one year follow up period. Regarding the clinical assessment there was no significant difference in both groups with consideration of continuous glycemic control and optimum oral hygiene measures.

ACKNOWLEDGMENT

The authors would like to acknowledge the patients who agreed to participate in this study.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

FUNDING

Not applicable

REFERENCES

1. De Bruyn H., Christiaens V., Doornewaard R., Jacobsson M., Cosyn J., Jacquet W. and Vervaeke S. : Implant surface roughness and patient factors on long-term peri-implant bone loss. *Periodontology* 2000. 2017; 73, 218–227. <https://doi.org/10.1111/prd.12177>
2. Chappuis V., Rahman L., Buser R., Janner S.F.M., Belsler U.C. and Buser D.: Effectiveness of contour augmentation with guided bone regeneration: 10-year results. *Journal of Dental Research*. 2018; 97, 266– 274. <https://doi.org/10.1177/0022034517737755>
3. Kim T., Jang J., Kim H., Knowles J. and Ku Y.: Biomimetic approach to dental implants. *Curr Pharm*. 2008; 14(22):2201-11.

4. Al Amri M.D. and Abduljabbar T. S.: Comparison of clinical and radio- graphic status of platform-switched implants placed in patients with and without type 2 diabetes mellitus: a 24-month follow-up longitudinal study. *Clin. Oral Impl. Res.* 2017; 28: 226–230 doi: 10.1111/clr.12787
5. Hsu Y.T., Lin G.H. and Wang H.L.: Effects of platform-switching on peri-implant soft and hard tissue outcomes: A systematic review and meta-analysis. *The International Journal of Oral & Maxillofacial Implants.* 2017; 32: e9–e24. <https://doi.org/10.11607/jomi.5140>
6. López L., Calvo L., Martín B., Gomez G. and López M.: Implant platform switching concept: An updated review. *Med Oral Patol Cir Bucal.* 2009;14.
7. Prosper L., Redaelli S., Pasi M., Zarone F., Radaelli G. and Gherlone E.F.: A randomized prospective multicenter trial evaluating the platform-switching technique for the prevention of post restorative crestal bone loss. *The Int J of Oral & Maxillofac. Implants.* 2009; 24: 299–308.
8. Vandeweghe S. and De Bruyn H.: A within- implant comparison to evaluate the concept of platform switching: a randomised controlled trial. *European Journal of Oral Implantology.* 2012; 5: 253–262.
9. Naujokat H., Kunzendorf B. and Wiltfang J.: Dental implants and diabetes mellitus—a systematic review. *International Journal of Implant Dentistry.* 2016;2:5 DOI 10.1186/s40729-016-0038-2
10. Khader Y.S., Dauod A.S., El-Qaderi S.S., Alkafajei A. and Batayha W.Q.: Periodontal status of diabetics compared with nondiabetics: a meta-analysis. *J Diabetes Complications.* 2006;20(1):59–68.
11. Abiko Y. and Selimovic D.: The mechanism of protracted wound healing on oral mucosa in diabetes. *Review. Bosn J Basic Med Sci.* 2010;10(3):186–91.
12. Michaeli E., Weinberg I. and Nahlieli O.: Dental implants in the diabetic patient: systemic and rehabilitative considerations. *Quintessence Int* 2009; 40:639–645.
13. Katyayan P.A., Katyayan M. and Shah R.J.: Rehabilitative Considerations for Dental Implants in the Diabetic Patient. *J Indian Prosthodont Soc.* July-Sept 2013; 13(3):175–183. DOI 10.1007/s13191-012-0207-9
14. Chrcanovic B.R., Albrektsson T. and Wennerberg A.: Diabetes and oral implant failure: a systematic review. *J Dent Res.* 2014;93(9):859–67.
15. Oates T.W., Huynh-Ba G., Vargas A., Alexander P. and Feine J.A.: Critical review of diabetes, glycemic control, and dental implant therapy. *Clin Oral Implants Res* 2013; 24:117–127.
16. Oates T.W.Jr, Galloway P., Alexander P., Vargas Green A., Huynh-Ba G., Feine J., et al.: The effects of elevated hemoglobin A (1c) in patients with type 2 diabetes mellitus on dental implants: survival and stability at one year. *J Am Dent Assoc* 2014; 145:1218–1226.
17. Takeda M, Ojima M, Yoshioka H, et al. Relationship of serum advanced glycation end-products with deterioration of periodontitis in type 2 diabetes patients. *J Periodontol.* 2006;77(1):15–20.
18. Dogan S., Kurtiş M., Tuter G., Serdar M., Watanabe K. and Karak S.: Evaluation of clinical parameters and levels of proinflammatory cytokines in the crevicular fluid around dental implants in patients with type 2 diabetes mellitus. *Int J Oral Maxillofac Implants.* 2015;30(5): 1119–1127
19. Javed F. and Romanos G.E.: Impact of diabetes mellitus and glycemic control on the osseointegration of dental implants: a systematic literature review. *Journal of Periodontology.* 2009; 80: 1719–1730.
20. Gomez-Moreno G., Aguilar-Salvatierra A., Rubio Roldan J., Guardia J., Gargallo J. and Calvo-Guirado J.L.: Peri-implant evaluation in type 2 diabetes mellitus patients: a 3-year study. *Clin Oral Implants Res.* 2015;26:1031–1035.
21. Khatavkar P.R., Biswas K.P., Gangde P., Mishra A.K., Laddha R. and Avhad R.: Comparison of peri implant soft tissue and crystal bone status of dental implant placed in pre diabetic, diabetic and non-diabetic individuals. *European Journal of Molecular & Clinical Medicine.* 2021; 8(1):875-879.
22. American Diabetes Association. 6. Glycemic Targets: Standards of Medical Care in Diabetes-2019. *Diabetes Care.* 2019 Jan; 42(1):S61-S70. doi: 10.2337/dc19-S006.
23. Salvi GE, Lang NP. Diagnostic Parameters for Monitoring Peri-Implant Conditions. *Int J Oral Maxillofac Implants.* 2004;19 Suppl:116–127
24. Stoker G, van Waas R, Wismeijer D. Long-term outcomes of three types of implant supported mandibular overdentures in smokers. *Clin Oral Implants Res.* 2012;23: 925-9.
25. Mombelli A., van Oosten M.A., Schurch E., Jr. and Land NP.: The microbiota associated with successful or failing osseointegrated titanium implants. *Oral Microbiol Immunol.* 1987; 2:145-51.
26. Misch C.E., Perel M.L., Hom-Lay Wang, Sammartino G., Galindo-Moreno P., Trisi P., Steigmann M., Rebaudi A., Palti A., et al.: Implant success, survival, and failure: the International Congress of Oral Implantologists (ICOI) Pisa Consensus Conference. *Implant Dent.* 2008 Mar;17(1):5-15. doi: 10.1097/ID.0b013e3181676059.

27. Grossi S.G., Skrepcinski F.B., Decaro T., Zambon J.J, Cummins D. and Genco R.J.: Response to periodontal therapy in diabetics and smokers. 1996 Oct;67(10 Suppl):1094-102. doi: 10.1902/jop.1996.67.10s.1094.
28. Turkyilmaz I., Eskow C.C. and Soganci G.: CAD/CAM Technology in Implant Dentistry. Current Concepts in Dental Implantology, IntechOpen. 2015:149-78.
29. Bholra M., Neely A.L. and Kolhatkar S.: Immediate implant placement: clinical decisions, advantages, and disadvantages. J Prosthodont: Implant, Esthetic and Reconstructive Dentistry. 2008; 17(7):576-581.
30. Kinsel R.P. and Liss M.: Retrospective analysis of 56 edentulous dental arches restored with 344 single-stage implants using an immediate loading fixed provisional protocol: statistical predictors of implant failure. Int J Oral Maxillofac Implants. 2007;22(5):823–830.
31. Al-Juboori M.J., Bin Abdulrahman S. and Jassan A.: Comparison of flapless and conventional flap and the effect on crestal bone resorption during a 12-week healing period. Dent Implantol Update. 2012; 23:9–16.
32. Lekholm U.: Immediate/early loading of oral implants in compromised patients. Periodontol 2000. 2003; 33:194–203.
33. Andrade C.A.S, Paz J.L.C., Simino de Melo G., Mahrouseh N., Januário A.L. and Capeletti L.R.: Survival rate and peri implant evaluation of immediately loaded dental implants in individuals with type 2 diabetes mellitus: a systematic review and meta analysis. Clinical Oral Investigations. 2022; 26:1797–1810 <https://doi.org/10.1007/s00784-021-04154-6>
34. Morris H.F., Ochi S. and Winkler S.: Implant survival in patients with type 2 diabetes: placement to 36 months. Ann Periodontol 2000; 5:157-65.
35. Balshi T.J. and Wolfinger G.J.: Dental Implants in the Diabetic Patient: A Retrospective Study. Implant Dent. 1999; 8:355-359
36. Al Amri M.D., Kellesarian S.V., Al-Kheraif A.A., Malmstrom H., Javed F. and Romanos G.E.: Effect of oral hygiene maintenance on HbA1c levels and peri-implant parameters around immediately-loaded dental implants placed in type-2 diabetic patients: 2 years follow-up. Clin Oral Implants Res. 2016; 27(11):1439–1443.
37. Al Amri M.D., Abduljabbar T.S., Al-Johany S.S., Al Rifaiy M.Q., Alfarraj Aldosari A.M. and Al-Kheraif A.A.: Comparison of clinical and radiographic parameters around short (6 to 8 mm in length) and long (11 mm in length) dental implants placed in patients with and without type 2 diabetes mellitus: 3-year follow-up results. Clin Oral Implants Res. 2017; 28(10):1182–1187.
38. Porter J.A., Von Fraunhofer.: Success or failure of dental implants? A literature review with treatment considerations. Gen Dent. 2005; 53(6): 423-32.
39. Adell R., Lekholm U., Rockler B., Brånemark I.: A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981; 10:387–416.
40. Ferreira S.D., Silva G.L., Cortelli J.R., Costa J.E. and Costa F.O. : Prevalence and risk variables for peri-implant disease in Brazilian subjects. J Clin Periodontol 2006; 33:929–935.
41. Sghaireen M.G., Alduraywish A.A., Srivastava K.C., Shrivastava D., Patil S.R., Al Habib S., et al.: Comparative evaluation of dental implant failure among healthy and well-controlled diabetic patients-a 3-year retrospective study. Int J Environ Res Public Health 2020; 17:5253–5262.
42. Mombelli A., van Oosten M.A., Schurch E., Jr., Land NP.: The microbiota associated with successful or failing osseointegrated titanium implants. Oral Microbiol Immunol. 1987; 2:145-151
43. Vijayalakshmi R. and Ramakrishnan T.: Platform switch dental implants -Search for evidence: An overview. SRM J Res Dent Sci. 2016; 7:101-105.
44. Fernando G., Wilfried W., Jörg W., Salomão R., Maximilian M., Eleonore B., et al.: Platform switch versus platform match in the posterior mandible.1-year results of a multi-centre randomized clinical trial. J Clin Periodontol. 2014; 41(5):521-529.
45. Eisner S., Jerry C., Chi T., Yung H., Haw H., Nai T., et al.: Dental Implant Surrounding Marginal Bone Level Evaluation: Platform Switching versus Platform Matching—One-Year Retrospective Study. Int Bio Med Res. 2017.
46. Maeda Y., Miura J., Taki I. and Sogo M.: Biomechanical analysis on platform switching. Is there any biomechanical rationale? Clin Oral Implants Res. 2007; 18(5):581-584. 2011; 22(2):317-323.
47. Rodríguez X., Vela X., Segalà M., Rodado C., Méndez V., Mata M. et al. : Biomechanical repercussions of bone resorption related to biologic width: A finite element analysis of three implant-abutment configurations. Int J Periodontics Res Dent. 2009; 29(5):479-487.
48. Lazzara R. and Porter S.: Platform switching: A new concept in implant dentistry for controlling post-restorative crestal bone levels. Int J Periodontics Res Dent. 2006; 26:9-17.
49. Prasad D., Shetty M., Bansal N. and Hegde C.: Crestal bone preservation: A review of different approaches for successful implant therapy. J of Indian Dent Res. 2011; 22(2):317-323.
-