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The Effect of Platform Switching on The Supporting Structures of Implant – Retained Mandibular Overdenture

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Abstract

This split- mouth design study aims to evaluate the effect of platform switched dental implant on the peri-implant bone loss. Fourteen completely edentulous patients were selected and thoroughly examined clinically and radiographically. All were rehabilitated with two implant supported mandibular overdenture, one platform switching implant in one side and a non-platform switching implant in the other side, at the inter-foramina area. A linear measurement system supplied by cone-beam computed tomography (CBCT) was used to evaluate peri-implant bone loss. Records were obtained at implant loading (baseline), six months and twelve months follow-up intervals. Lower values of peri- implant bone loss were detected in the platform switching implant, which might result from the horizontally re-established biological width, in which the re-positioned bone tissues and subsequently soft tissues are in a more horizontal direction. Along with the inward shift occurred to the inflammatory cell infiltrate away from the adjacent crestal bone. The study concluded that the platform-switching approach improves the preservation of peri-implant bone loss.

Keywords: Platform switching, peri-implant bone loss, linear measurement system, CBCT, biological width.

Introduction

Restoration of the edentulous mandible with an implant retained over denture with two implants placed in the inter-foramina region has been considered one of the most common prosthodontic treatment options [1].

The success of an implant is governed by many factors, most importantly, bone quality and quantity. The physicochemical characteristics of the dental implant surface, such as roughness, topography, chemistry, and electrical charge affect the biological reactions occurring at the tissues - implant interface. In addition, implant design and implant/abutment connection have been proven to affect the rate of osseointegration [1].

Implant-abutment connections may be internal or external. Although prosthetic success with the external connection remains high, the most common complication is screw loosening. This arises from

the screw being the weakest link between the implant, abutment connection, screw, and bone, where the screw alone secures the abutment. Another problems associated with external connection are the higher frequency of rotational misfit, less esthetic results and insufficient microbial seal [2].

A new concept of internal connection, which has many variations, was introduced for better joint strength, microbial seal and esthetics. Especially the friction-fit design, in which the stability of connection is not dependent on the screw, but rather gained from the frictional resistance, resulted from contact between the conical mating parts of the abutment and the implant [2].

The approach of platform switching was established to control the peri-implant bone loss after implant placement. This system comprises of the placement of smaller diameter abutment on wider-diameter implant, which enhances the stress distribution and reduces the peri-implant bone loss in the first year of loading [2].

The effect of platform switching is clinically significant in several situations, where anatomic vital structures such as the sinus cavity or the alveolar nerve restrict the residual bone height. The platform-switching approach decreases bone resorption and increases the biomechanical support and soft tissue around dental implants [2].

The presence of a biologic width around osseointegrated implants has been improved with the concept of platform switching. This occurs around implants after uncovering at stage-two surgery, irrespectively to whether the implants have been loaded. The biologic explanation for the development of a biologic width is that when bone is subjected to the oral environment, it covers itself with periosteum and connective tissue. Furthermore, connective tissue covers itself with epithelium [3].

Although numerous studies have been conducted to assess the effect of implant/abutment connection on peri-implant bone loss, however limited data exists in the literature concerning the effect of platform switching on the osseointegration process in completely edentulous patients.

Materials and Methods

In this split-mouth design study, fourteen completely edentulous patients were selected from Out-Patient Clinic, Prosthodontic Department, Faculty of Dentistry, Ain-Shams University to participate in this study.

Inclusion Criteria:

-Male patients with age ranged between 55-65 years.
-Patients had completely edentulous upper and lower arches and been totally edentulous for at least 1 year before the placement of implants.
-The residual ridge had adequate height and width and covered with firm dense fibrous muco-periosteum.

-Patients had normal maxilla-mandibular relationship (Angel's class I ridge relationship) with adequate inter arch restorative space of at least 12mm.
-Patients with good oral hygiene.

Exclusion Criteria

-Smokers and drug abusers.
-Patients with systemic diseases such as cardiovascular diseases, metabolic disorders, immunological diseases, hyperparathyroidism, osteoporosis, and compromised psychological conditions.
-Patients taking any drugs that may affect bone metabolism.
-Patients suffered from neuromuscular disorders.
-Patients submitted to chemotherapy or previously received local radiotherapy involving the head and neck region as a treatment for malignancy.
-Patients suffered from xerostomia.
-Patients with para functional habits as bruxism or clenching.
-Patients suffering from temporomandibular joint disorders.
-Patients had history of tooth extraction due to periodontal disease.
-Patients with impacted teeth or remaining roots.
-Patients presented with any flabby tissues, sharp bony spicules, bony undercuts, thin ridge or any abnormalities at the residual alveolar ridge.
-Patients having large tongue, high frenal or muscle attachments.

All Patients were rehabilitated with implant supported mandibular overdenture, receiving two different implant systems .A New Standard Non-Platform Switching (NST) dental implant [1] (4.2 mm in diameter and 9 mm in length) for one side, and a Platform Switching Standard (P-ST) dental implant [2] (4.2 mm in diameter and 9mm in length) for the other side.

Following the randomly generated numbers created in an excel spreadsheet, the side on which platform switching design was applied.

-Patient examination

1-Thorough History Taking

2-Patient examination

A-Extra-oral examination

[1] New Standard , Multysystem CC implants, 7094209, Italy.
[2] Platform Switching Standard , Multysystem CC implants,7024209,Italy.

-Was performed to detect any swellings, symmetry of the face, and examination of the lips contour, support and length. The smile line was also evaluated.
-Evaluation of vertical dimension of the face, determining maxilla mandibular relation (Angle's skeletal morphology type) was done.
-Examination of any temporomandibular disorders was carried out through palpation of the joint during opening, closing and lateral movements.

B-Intra-oral examination

-Visual and digital intraoral examination were carried out for the mucosa covering the mandibular residual ridge to ensure that the mucosa was firm, healthy and free from signs of inflammation, infection, or irritation. Also, the alveolar ridge at the prospective implants sites was palpated to ensure the absence of any flabby tissues, bony undercuts, sharp bony edge and thin ridge or any abnormalities.
-Examination of tongue, soft palates, frenula, saliva, size of dental arch, ridge form, inter arch space was done.

C-Radiographic examination

-Pre-operative Cone Beam Computed Tomography[3] (CBCT) was taken for all patients, while wearing their previously constructed dentures, upon which gutta percha rods were added to the area of interest (canine/premolar area).

D-Evaluation of diagnostic casts

-Upper and lower modelling compound impressions [4] were made with accurately modified stock trays and poured into dental stone[5] to obtain the diagnostic casts.
-A provisional centric jaw relation was recorded and the diagnostic casts were mounted on a mean value articulator to assess the opposing ridge relationship and the available restorative inter arch space of at least 12mm.

-Pre-surgical protocol

1-Prosthetic Procedure

Complete denture construction

-Upper and Lower primary impressions were made in properly selected and adjusted stock trays using modelling compound[6] . And then the impressions were poured into dental stone[7] to obtain the study casts. Self-cure acrylic resin special trays were fabricated on the diagnostic casts.

[3] i-CAT FLX series Imaging Sciences International, LLC 1910 N Penn Road, Hatfield, PA 19440.
[4] Kerr Impression Compound cakes, Red. Via Strecca 4,6934 Bioggio, Switzerland.
[5] Dental Stona A hard, Type M gypsum, Zeta industria zingerdi, Italy.
[6] Kerr Impression Compound cakes, Red. Via Strecca 4,6934 Bioggio, Switzerland.
[7] Dental Stona A hard, Type M gypsum, Zeta industria zingerdi, Italy.

-In the pre-fabricated special trays, secondary impressions were made. Border tracing was done using green stick compound[8] followed by secondary impressions using zinc oxide/Eugenol[9] impression material. Then secondary impressions were poured into dental stone to obtain the master casts.

-Occlusion blocks were constructed, facebow[10] record was made to mount the upper cast on a semi-adjustable articulator[11] , and then mandibular cast was mounted by centric occluding relation using inter-occlusal wax technique. Protrusive record was made to adjust the horizontal condylar guidance of the articulator.

-The waxed-up dentures were tried in the patient's mouth to confirm proper extension and even contact between all the posterior teeth and harmony between centric occlusion and centric relation at the predetermined vertical dimension of occlusion. The trial dentures were flasked and processed into heat-cured acrylic resin. Then laboratory remount was performed to adjust the occlusion.

-The mandibular denture was duplicated for all patients with clear acrylic resin to be used as a surgical stent.

-Surgical Procedure

I-First stage surgery

-All Participants were prepared for the surgery following the typical protocol for the implant surgery which includes antibiotics[12] coverage for 24 hours prior to surgery as one tablet every 12 hours, and continued for a week after the surgery, non-steroidal anti-inflammatory drug[13] was prescribed to the patients, one capsule a day, all patients were educated to rinse with chlorohexidine mouth wash[14] three times a day starting three days before surgery.

Implant selection

-For every patient, two designs of dental implants were selected for insertion in the mandibular ridge at the canine area, one design on each side.

A) New Standard Non-Platform Switching NST, tapered screw type implant, internal hex, 4.2 mm diameter and 9 mm length, polished treated neck with micro-throats and H.F.R (high frequency roughness) surface[15] was inserted on one side at the canine area.

[8] Perfectin, S.A.I.C., HUBAC, BUENESAIRES, Argentina.
[9] S.S White Impression Paste, S.S White Group, England.
[10] Bio-Art Standard Facebow. Bio-Art Equipamentos OdontolÓgicos LTDA. Brasil
[11] Bio-Art Articulator A7 Fix. Bio-Art Equipamentos OdontolÓgicos LTDA. Brasil.
[12]Augmentin 1gm Glaxo-Smith Kline- Becheem, Great Britain.
[13] Ibuprofen, Knoll AG ,Ludwigshagen, Germany.
[14]Chlorohexidine, Kahira Pharm. & Chem. Ind. Co. Cairo, Egypt.
[15] New Standard , Multysystem CC implants, 7094209, Italy.

B) Platform Switching Standard, tapered screw type implant P-ST, internal hex, 4.2 mm diameter and 9 mm length, polished treated neck with micro-throats and H.F.R (high frequency roughness) surface[16] was inserted on the other side at the canine area .

Surgical Steps

-Patients were instructed to rinse their mouth with 0.12% Chlorohexidine mouth wash for three minutes before surgery.

-Patients were given bilateral nerve block anesthesia Articaine Hydrochloride[17] followed by ring infiltration anesthesia in the surgical area.

-The positions of two implants were determined by the use of the already constructed surgical stent.

-Full crestal incision was carried out using a Bard Parker blade no.15 bisecting the mucosa and periosteum at the canine-premolar area from one side to the other.

-A sharp muco-periosteal elevator was used to reflect the flap on the lingual side then on the buccal side keeping the intact periosteal coverage.

-A 1.8 mm diameter centring drill was first used to create the insertion point, followed by 2.3 mm diameter pilot drill (short) for the preparation of the implant site perpendicular to the occlusal plane under copious irrigation with sterile saline.

-A Sequential drilling was performed using a first millimeter marked drill (2.55 mm diameter) to the full planned depth (9mm) followed by a 2.85 mm marked trimmin drill ending with a countersink of 3.6 mm diameter, under copious irrigation. And the implant sites were verified with parallel pins to check the implants alignment.

-The vial was opened and the standard non-platform switching implant was inserted and screwed manually with a hand ratchet in the patient's canine area, while the platform switching implant was inserted in the patient's other side. Both implants were screwed at a crestal bone level with a torque of 35 Ncm .

-The muco-periosteal flap was then repositioned and approximated with no tension and sutured with 3.0 resorbable interrupted sutures.

[16] Platform Switching Standard , Multysystem CC implants,7024209,Italy.
[17] Articaine HCL, Ubeistesin Forte, 3M ESPE, Germany.

Post-Surgical Protocol

-The fitting surface of the denture corresponding to the sutures was relieved by about 2mm. Then a soft liner material[18] with sufficient thickness was added to avoid any contact with the overlying prosthesis.

-Patients were informed to apply ice packs after the surgery, and to follow the post-surgery medications protocol by taking antibiotics[19], and an oral non-steroidal anti-inflammatory medication[20], along with Chlorohexidine mouth wash.

-Patients were educated to maintain their denture clean, remove it during the night soak it in tap water and to consume soft diet for a week.

-Later, they were recalled for healing assessment, detection of sore spots and denture inspection to detect any pressure areas that needed to be relieved.

II-Second stage surgery

-Patients were recalled after three months and a periapical radiograph was taken to ensure lack of any radiolucency around the implants.

-Each implant position was detected by a sterile explorer, then, local anesthesia was infiltrated at the implants' sites, and each implant was surgically uncovered to install the ball abutment by means of keyhole crestal incision.

-Then, a screw driver was used to unthread the cover screws. Then ball abutments were screwed into the implants with a torque not exceeding 20 Ncm.

-Metal housings were positioned over the equivalent O-ball attachments, and the fitting surface of the overdenture opposite to each housing position was marked then relieved by an abrasive stone.

-An elastomeric wax spacer was placed to block out undercuts, permitting the O-ball half to protrude uncovered.
-The metal housings were re-placed over the implant ball abutments with the block out shims.

-A direct pickup technique was followed using a hard pickup material[21] .The patients were instructed to close in centric occlusion for about 10 minutes until full setting of the pickup material then, the denture was removed, cleaned and trimmed.

-Further occlusal adjustments were made to eliminate any occlusal interference.

[18] Mollosil, chair-side long-term soft relining material, Detax,Germany..
[19] Augmentin 1gm Glaxo-Smith Kline- Becheem, Great Britain.
[20]Alphintern, Amoun Pharmaceutical, Egypt.
[21] Hard relining material, Acrostone Dental, Egypt.

-Post-insertion Evaluation

Patients evaluation

-Patients were recalled frequently for post insertion inspection and adjustments. Follow ups were scheduled at the time of implant loading, six and twelve months to provide the radiographic records necessary for the assessment of the peri-implant bone loss using CBCT scan.

Radiographic evaluation

-CBCT images were taken at standardized settings for all scans.

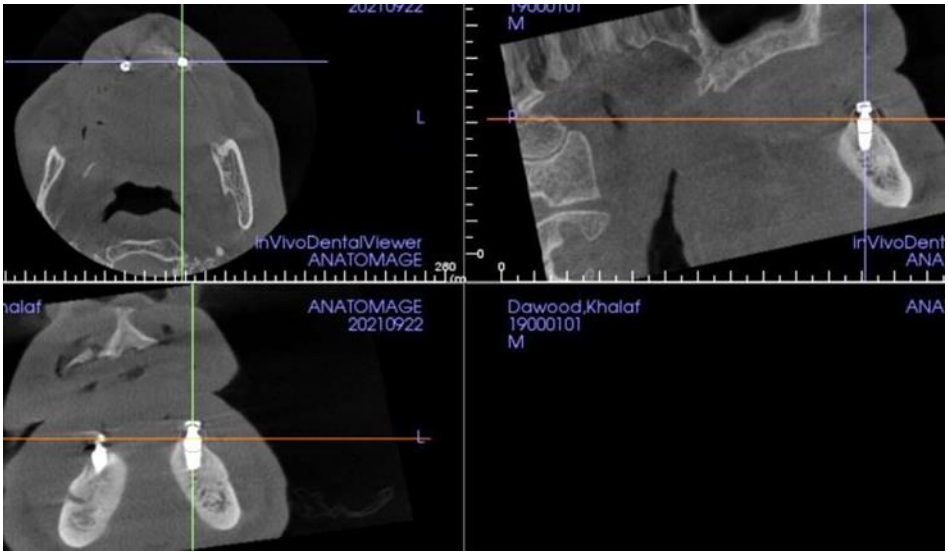
-In the obtained CBCT images, the axial plane was adjusted to pass through the superior surface of the implant fixture in order to view the panoramic image properly, onto which a reconstructed curve was oriented.

-Both sagittal and coronal planes were adjusted to divide the implant into two equal halves mesio-distally and labio-lingually respectively (Fig.1).

-Peri-implant bone loss was measured in all four surfaces, buccal, lingual, mesial and distal, using the linear measurement tool supplied by the Invivo 3D imaging software.

-Two horizontal lines parallel to each other were drawn so that one line was passing through the implant/abutment interface and the other line was passing through the first implant/bone contact point. Then the distance between these two lines was measured in order to calculate the amount of peri-implant bone loss, labio-lingually and mesio-distally (Fig.2).

-The values of these measurements were documented at each follow up visit in every patient's chart, from which mean values of total peri-implant bone loss were calculated.Then, the results were collected, tabulated and statistically analyzed.



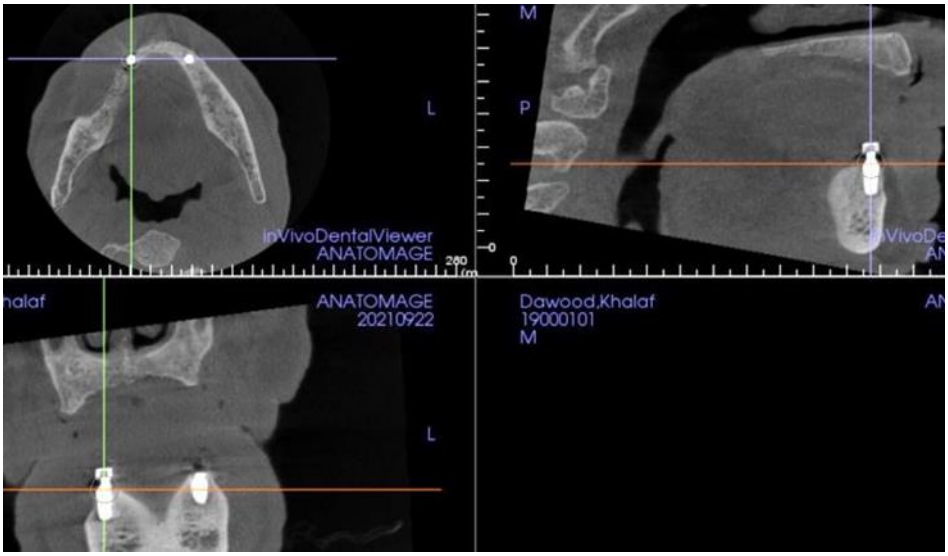


Fig. 1: Orientation of the axial, sagittal and coronal planes

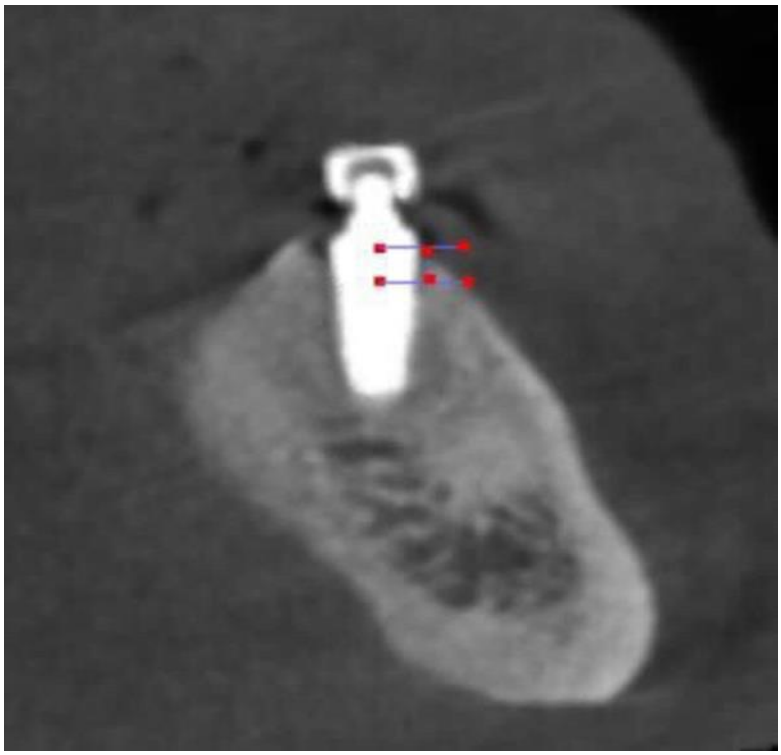


Fig.2: Peri-implant bone loss measurement

Statistical analysis:

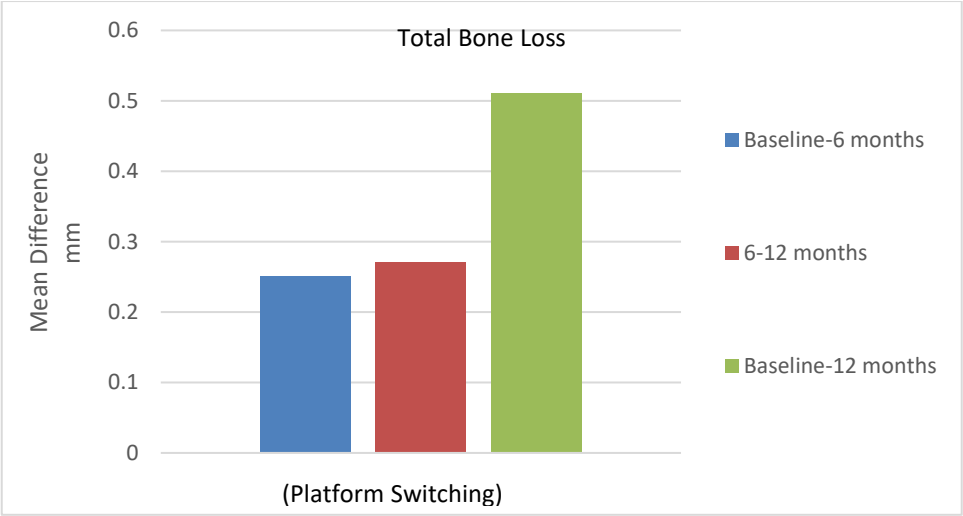
Data were presented as mean difference and standard deviation. Intra and intergroup comparisons were done utilizing paired t-test and student t-test respectively. The significance level was set at $P \leq 0.05$

for all tests. Statistical analysis was performed with R statistical analysis software version 4.1.1 for Windows[22].

Results

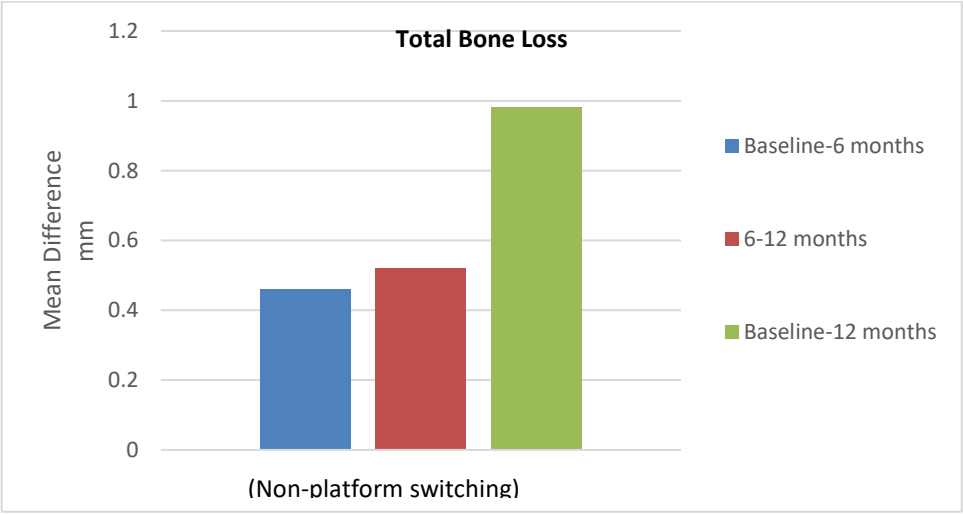
1. **Intragroup comparisons of total bone loss for all the implants (mm):**

A - Group I (Platform switching implants)



Bar chart showing mean difference of total bone loss (mm) in group I (platform switching standard implants)

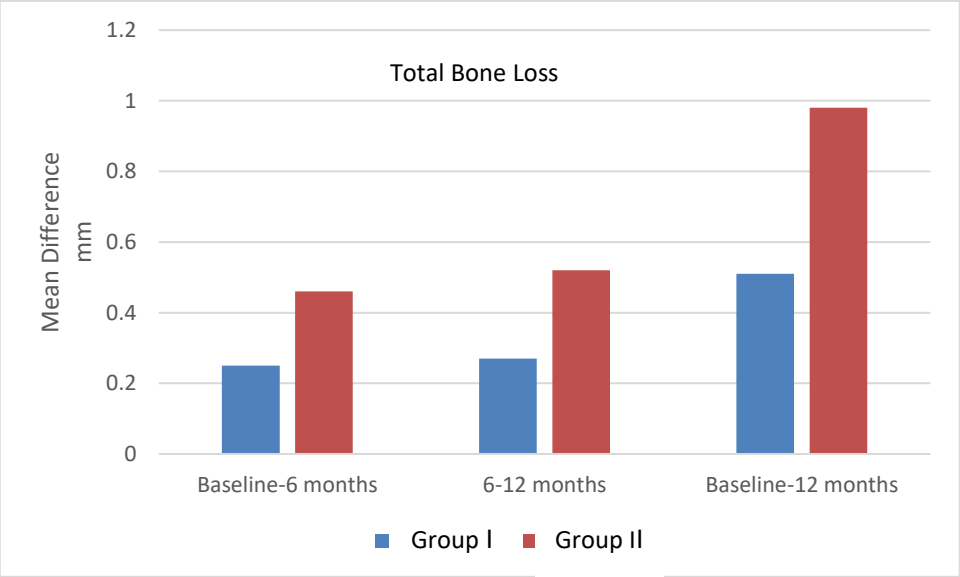
B- Group II (Non-platform switching implants)



Bar chart showing mean difference of total bone loss (mm) in group II (Non-platform switching implants)

[22]R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

2. Comparison of total peri-implant bone loss (mm) between the two groups:



Bar chart showing mean difference of total bone loss (mm) in both groups

Discussion

The results of this split mouth design study revealed the criteria of implant success in both groups of dental implants, as detected in the regular follow ups assessment.

This may be the result of proper patient selection, thorough clinical and radiographic assessment, patient good oral hygiene, patient compliance, control of occlusal load and attaining primary implant stability.

Among the reasons that might enhance the implant success rate is the split mouth technique approach in this study. In which the patients acted as their own controls, preventing any carry across effects, contamination possibilities and eliminating inter-subject variability [4].

The mean amount of total bone loss measured in both groups was found to be within the normal range throughout the first year after implant loading. It was recorded to be 0.51mm and 0.98mm in platform switching and non-platform switching dental implants respectively. These findings are fully consistent with a study proposed that vertical marginal bone loss at the peri-implant surfaces must not exceed 1-1.5 mm throughout the first year of function and 0.2 mm afterwards [5].

Peri-implant bone loss that occurred during the follow up period may be attributed to the surgical trauma resulted from drilling or as an early manifestation of wound healing or remodeling process. Or even due to bacterial accumulation. This goes in agreement with a study conducted by Adell et al [6].

This bone loss could also be explained by the concentration of micro-damage in the bone after implant placement and that forces applied to the implants are concentrated at the crestal bone rather than along the entire implant/bone interface [7].

Higher peri-implant bone loss was detected in the non-platform switching implants compared to that of platform switching implants during all time intervals. The platform switching implant contributes to preserve the height and width of crestal bone and the crestal peak between adjacent implants as well as limiting the circumferential bone loss [7-9].

In addition, the reduced amount of corrosion by-products, metal iron release and wear debris which derived from the materials used for the prosthetic treatment and released into the surrounding peri-implant tissues. These by-products elicit a foreign body reaction that initiates an osteolytic response. This may account to the results of this study [10-13].

Another reason is that platform switching implants are known to conserve marginal bone from stress concentration, that mostly located at implant / abutment interface [14,15]. This was reported by studies conducted on implant-abutment configurations and most probably this may contribute to the results of this study.

Also there is a biologic reason of marginal bone maintenance in platform switching implants, related to a horizontally re-established biological width, in which the re-positioned bone tissues and subsequently soft tissues are in a more horizontal direction. This led to a horizontal and inward shift of implant-abutment interface away from the outer edge of the implant platform. This explanation was consistent with the observations of Lazzara and Porter [16].

Moreover, the reduced bone loss in the platform switch configuration might be the outcome of the inward shift occurred to the inflammatory cell infiltrate away from the adjacent crestal bone and subsequently reduce the possible impact of microgap on the marginal bone. This coincided with a study examined the effect of crestal bone preservation and implant success [17].

Conclusion

Statistical data for this split-mouth design study revealed:

-Statistically significant peri-implant bone loss within the acceptable limit for both studied groups at all follow up intervals.

-The calculated mean values of peri-implant bone loss revealed significantly lower values for Group I (Platform switching implants) compared to Group II (Non-platform switching implants) during all the recall appointments.

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