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Comparative evaluation of vertical bone loss around root form dental implants with platform switching and platform matching design: An in-vivo study

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ABSTRACT

Aim

To radiographically evaluation and compare the crestal bone loss observed between platform match and platform switch design of implant-abutment after prosthetic loading and to find out which design is better for long term survival of implant.

Materials and Methods:

The sample size comprised of 30 implants with prosthesis in mandibular posterior region. Patients included in study were of age group 20-50 years. The participants were divided in Group 1 (platform match) and Group 2 (platform switched). Radiographic evaluation of marginal bone levels was done after delayed prosthetic loading of implant. Radiographs were taken for at regular interval for 1 year.

Result: On mesial side, marginal bone loss (MBL) at 0 month is higher in Platform switch (test) group with a t value of -0.312 and is statistically non-significant with a p value of 0.757. At the end of 1 month and 3 months, it is higher in Platform match (control) group with a t values of 0.188 & 0.894 respectively and is statistically non-significant with a p values of 0.852 & 0.379 respectively. At the end of 6 months and 1 year, it is higher in Platform match (control) group with a t values of 2.332 & 3.386 respectively and is statistically significant with a p values of 0.027 & 0.002 respectively. On distal side, marginal bone loss at 0 month is higher in Platform switch (test) group with a t value of -1.257 and is statistically non-significant with a p value of 0.219. At 1 month, marginal bone loss is higher in Platform switch (test) group with a t value of -0.824 and is statistically non-significant with a p value of 0.417. At the end of 3 months MBL is higher in Platform match (control) group with a t value of 0.112 and is statistically non-significant with a p value of 0.912. At the end of 6 months and 1 year, MBL is higher in Platform match (control) group with a t values of 0.876 & 1.301 respectively and is statistically non-significant with a p values of 0.388 & 0.204 respectively.

Conclusion: The level of peri-implant crestal bone loss does not differ significantly during first 6 months among two different implant–abutment connection designs. The level of peri implant crestal bone changes significantly with the time interval after 6 months to 1year in platform match group, while in platform switch group bone levels are preserved after that.Platform switching showed a positive impact in maintenance or even enhancement of crestal bone levels when compared with platform matching abutments, allowing to a long term survival of implant.

I. INTRODUCTION

Dental implant therapy has become the ideal method of oral rehabilitation after missing natural dentition and has been recognized as a reliable and predictable tool for dental reconstruction, necessitating that multiple factors are reached for long-term treatment success and esthetics.[1]

Extensive work is being done to improve the designing of implants in order to achieve better aesthetics and function[2]. To maintain long-term implant stability, it is important to minimize bone loss around the implant, as well as the soft tissue atrophy that accompanies it.[3]

The success of the osseointegration of dental implants has been widely described in the literature[4]. The preservation of the peri-implant bone is one important factor for success.Only with careful considerations of the biological principles of the peri-implant soft and hard tissues, as well as an appropriate selection of implant type and position, can a functional andesthetic treatment result be achieved.[5]

However, after osseointegration has taken place, it is frequent to observe a loss of bone around the neck of the implant once it is subjected to masticatory loading conditions. This bone loss takes place in the vicinity of the implant-abutment interface, space known as micro-gap, which is a confluence area of bone tissue and soft tissue [4-6].

Dental implant can be considered successful if peri-implant crestal bone loss is less than 1.5 mm during the first year after implant placement and less than 0.2 mm annually

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thereafter.[7]Factors that are the most likely causes early crestal bone loss around implants are: (1) the micro-gap, (2) the implant crest module, (3) occlusal overload, and (4) the biologic width around the dental implant[8, 9].

Numerous studies have shown that bone resorption around the implant neck does not start until the implant has been uncovered and exposed to the oral environment. Exposure invariably leads to bacterial contamination of the gap between the implant and the superstructure.[10]

When an external agent invades the biologic width, the epithelium responds by migrating beyond the damaging agent in an attempt to isolate it and create a defensive distance that ensures periodontal integrity. This results in bone resorption, which ensures the reestablishment of the biologic width dimensions. This process is also observed around natural teeth when the biologic width is invaded by formation of calculus or infra-gingival margins of crowns.[11-13](fig 1).

Platform matching means using the prosthetic components of same diameter as that of diameter of implant platform. (Fig 2). The concept of "platform switching" refers to use of prosthetic components of smaller diameter than the platform of the implant, this connection shifts the perimeter of the IAJ inward toward the central axis (i.e. The middle) of the implant.[10-13](fig 2).

Aim & Objectives

Aim

Radiographic Evaluation and Comparison of crestal bone loss observed between platform match and platform switch design of implant-abutment after prosthetic loading and analyse which design is better for long term survival of implant.

Objectives

1) To determine the bone loss on mesial and distal aspect of platform match and platform switch design radiographically.
2) To compare and evaluate the values to achieve optimum implant design.

II. MATERIALS & METHOD

The study was carried out in the Department of Prosthodontics, crown and bridge, Government Dental College & Hospital, Ahmedabad. It was approved by the ethical committee.Patient were explained about the study in detail, about the procedure which was to be carried out and were willingly allowed to be the part of study. Brief clinical details were recorded of each patient. A written consent was obtained from the subjects selected.

The sample size comprised of 30 implants with prosthesis in mandibular posterior region. Patients included in study were of age group 20-50 years.

PATIENT SELECTION CRITERIA

1).Inclusion Criteria

- Patients with overall good health without any major medical history
- Cases requiring DELAYED LOADING implant placement
- Absence of activeinfection around the surgical site
- Absence of parafunctionalhabits (bruxism, clenching)

2). Exclusion Criteria

- Presence of any local or systemic disease
- Oral parafunctional habit,non-treated periodontal disease
- Inadequate bone volume
- Poor oral hygiene

Armamentarium used for this study

- Cruxell – Cruxcan PSP film (Fig. 3)
- Rinn XCP (extension cone paralleling) device (Dentsply) (Fig. 4)
- Addition silicone rubber base material (Affinis by coltene)
- Cruxell – Cruxcan PSP Scanner (Fig.5)

The pre-surgical evaluation consisted of clinical and radiographic examinations (IOPA, OPG, CBCT scans as per the individual case treatment). The test and control implants were randomly assigned for each patient.

The following groups were created:

Group 1: Implants restored with matched diameter abutments (platform match).

Group 2: Implants restored with smaller diameter abutments (platform switched).

The osteotomies in all groups were performed using two stage surgical protocol. All implants placed were of Dentium Company. The abutments would be connected only after the implants have osseointegrated (3 months in mandible and 4 months in maxilla).

Prosthesis for group 1 i.e. Platform match design was made by using metal casting abutment in all cases and adapting the prosthesis design same as diameter of implant platform while for group 2 platform switch design was inbuilt in the abutment design of Dentium company.

Radiographic evaluation of marginal bone levels was done after delayed prosthetic loading of

implant. Radiographs were taken at the following intervals

1) On the day of prosthetic loading (baseline)
2) 1 month of prosthetic loading
3) Three month after loading
4) Six months after loading
5) One year after loading[1,11]

All radiographs were taken by Introral PSP film by paralleling technique using Rinn XCP (extension cone paralleling) device and they were examined using the computer software program – CRUXELL. (Fig. 6) The distance between implant abutment junction and the crestal bone was measured using digital scale tool for the measurement.

Patients bite were recorded with Putty index (Fig 7) to standardize the paralleling technique, so that at every time patient holds the paralleling device in same position (Fig 8). Subsequent radiographs were taken using these putty index at different time intervals.[14]

The Implant abutment junction in both the groups can be clearly defined. Figure 5 shows platform match design, figure 6 shows platform switch design. Each radiograph obtained from the PSP plate was saved in the computer program (fig 6). Bone loss observed in radiograph was calculated with help of this software. (Fig. 9).

All the radiographs taken at different time intervals were analyzed for bone loss measurement in sequential manner. Implant shoulder was taken as reference point for measuring bone loss (Fig. 10 and 11).

The measurements were taken for each of the radiographs as follow:

1) Mesial bone loss: The distance between mesial edge of implant platform point and the mesial point where the implant meets the alveolar crest point in millimetres.

2) Distal bone loss: The distance between distal edge of implant platform point and the distal point where the implant meets the alveolar crest point in millimetres.

The amount of bone level present at baseline was measured and was then compared with the amount of bone loss that occurred at different time intervals up to 1year after prosthetic loading.

III. RESULTS

- On **mesial side,** marginal bone loss (MBL) at **0 month** is higher in **Platform switch (**test) group with a t value of -0.312 and is statistically non-significant with a p value of 0.757. At the end of **1 month** and **3 months**, it is higher in **Platform match** (control) group with a t values of 0.188 & 0.894 respectively and is statistically non-significant with a p values of 0.852 & 0.379 respectively. At the end of **6 months** and **1 year**, it is higher in **Platform match** (control) group with a t values of 2.332 & 3.386 respectively and is **statistically significant**with a p values of 0.027 & 0.002 respectively.
- On distal side, marginal bone loss at **0 month**is higher in **Platform switch (test)** group with a t value of -1.257 and is statistically non-significant with a p value of 0.219. At**1 month**, marginal bone loss is higher in **Platform switch** (test) group with a t value of -0.824 and is statistically non-significant with a p value of 0.417. At the end of**3 months** MBL is higher in **Platform match** (control) group with a t value of 0.112 and is statistically non-significant with a p value of 0.912. At the end of **6 months and 1 year, MBL** is higher in **Platform match** (control) group with a t values of 0.876 & 1.301 respectively and is statistically non-significant with a p values of 0.388 & 0.204 respectively.

IV. DISCUSSION

In implant dentistry, the concept of platform switching is based on the placement of a narrow diameter abutment on a wider diameter implant. Implants placed according to the PS concept have implant-abutment junction placed closer to the centre of the implant (horizontal mismatch). Studies have reported that implants placed according to this concept undergo minimal peri-implant bone loss as compared with non-platform-switched implants.

Numerous studies have addressed this issue in recent years, clarifying some aspects and leading to improvements in implant design and protocols that have minimized this initial MBL.

In our study, implants with platform switching design showed less marginal bone loss compared to platform matched implant design in lone term. Many study has supported the role of platform switching in preservation of marginal bone.

Many studies have suggested that the anticipated bone loss that occurs around implants may be reduced or eliminated when implants are restored with smaller-diameter abutments. They concluded that implant design that incorporates the concept of platform switching is a simple and effective way to control circumferential bone loss around dental implants, helping to ensure a predictable esthetic result.

This can be explained by following facts,

(1) According to Rocío Alonso González et al [9](2012), inward movement of the IAJ is believed to shift the inflammatory cell infiltrate toward the central axis of the implant and away from the adjacent crestal bone.

(2) Increased connective tissue thickens laterally, which increases blood flow around that area.

(3) Inflammatory cell tissue (ICT) is confined above the level of the implant platform. These changes protect crestal bone (i.e. bone around the implant shoulder) from ICT. As a result, the biologic width does not decrease in order to cover up the ICT (i.e. to establish a biological seal), and as such, there is no bone remodelling (i.e. crestal bone loss).

Wang HL[8] (2009) concluded that platform switching resulted in a measurable but minimal effect on Von-mises stress in the crestal region of cortical bone.

Studies have shown that Platform Switching presented better biomechanical behaviour in relation to stress distribution on the implant but especially in the bone tissue. However, in the crown and retention screw, an increase in stress concentration was observed.

V. CONCLUSION

Within the limitations of this study, the following conclusions were drawn:

1. The level of peri-implant crestal bone loss does not differ significantly during first 6 months among two different implant–abutment connection designs.
2. The level of peri implant crestal bone changes significantly with the time interval after 6 months to 1year in platform match group, while in platform switch group bone levels are preserved after that.
3. Platform switching showed a positive impact in maintenance or even enhancement of crestal bone levels when compared with platform matching abutments, allowing to a long term survival of implant.

Further studies are needed to elucidate the responsible mechanisms and confirm the long term stability of the platform-switching technique.

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Figures

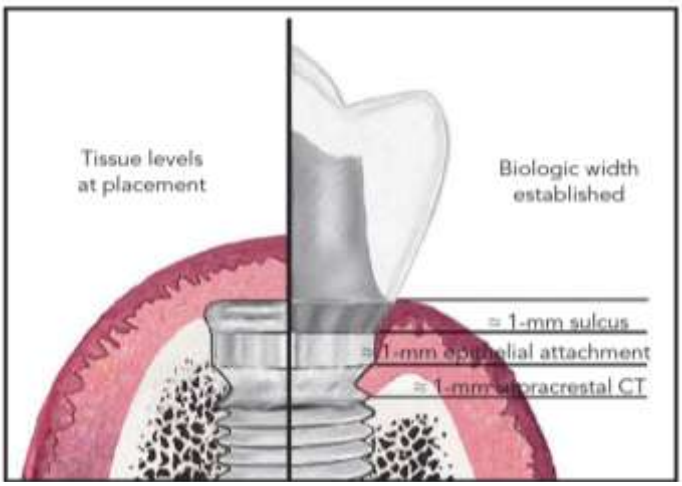

Figure 1 : Crestal bone level around a nonrestored, covered, two stage implant placed subcrestal (left) &postrestorative MBL located at first thread on a threaded dental implant approximately 1.5mm apical to IAJ (right).[13]

Figure 2: Platform match design (left) and Platform switch design (right)

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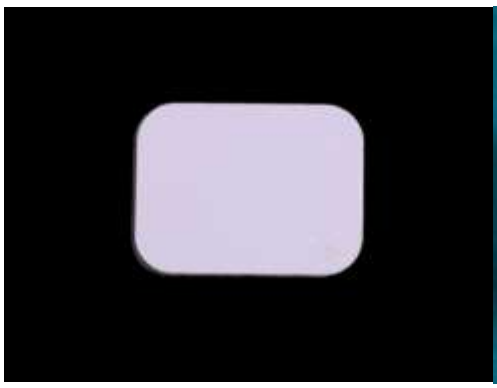

Fig. 3Cruxcan PSP filmFig. 4 XCP paralleling device with patients bite

Fig. 5 CRUCAN Scanner

Fig, 6. CRUXELL Computer Program

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Figure 7: Patients bite recorded in elastomeric material (Putty index)

Figure 8: Patient holding the paralleling device with putty index

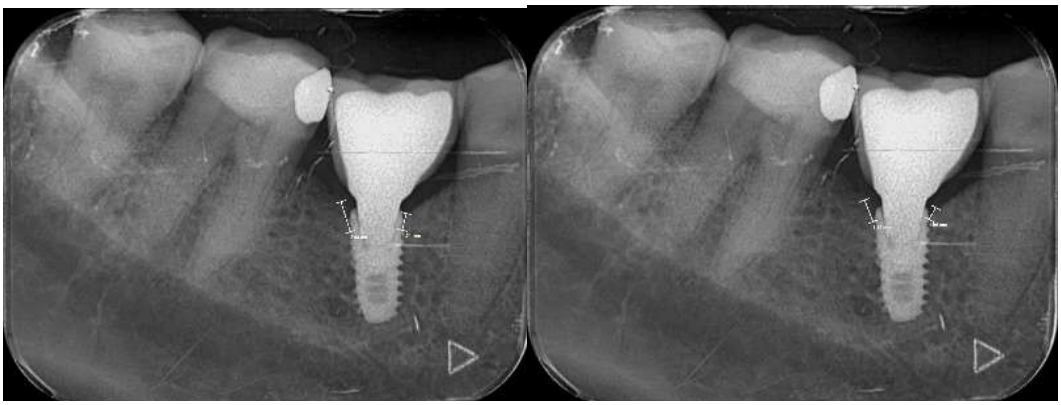
Fig. 9. Measurement of crestal bone loss using Digital Scale Tool provided by the program.

0 Months 1 Month 3 months

6 Months 12 Months

Fig. 10. Platform matching

0 Month 1 Month 3 Months



6 Months 12 Months

Fig. 11. Platform Switching

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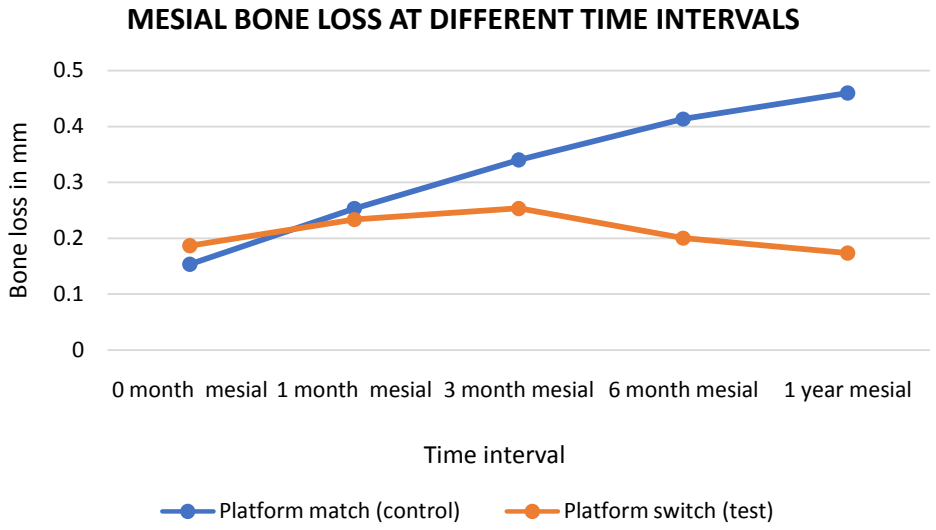
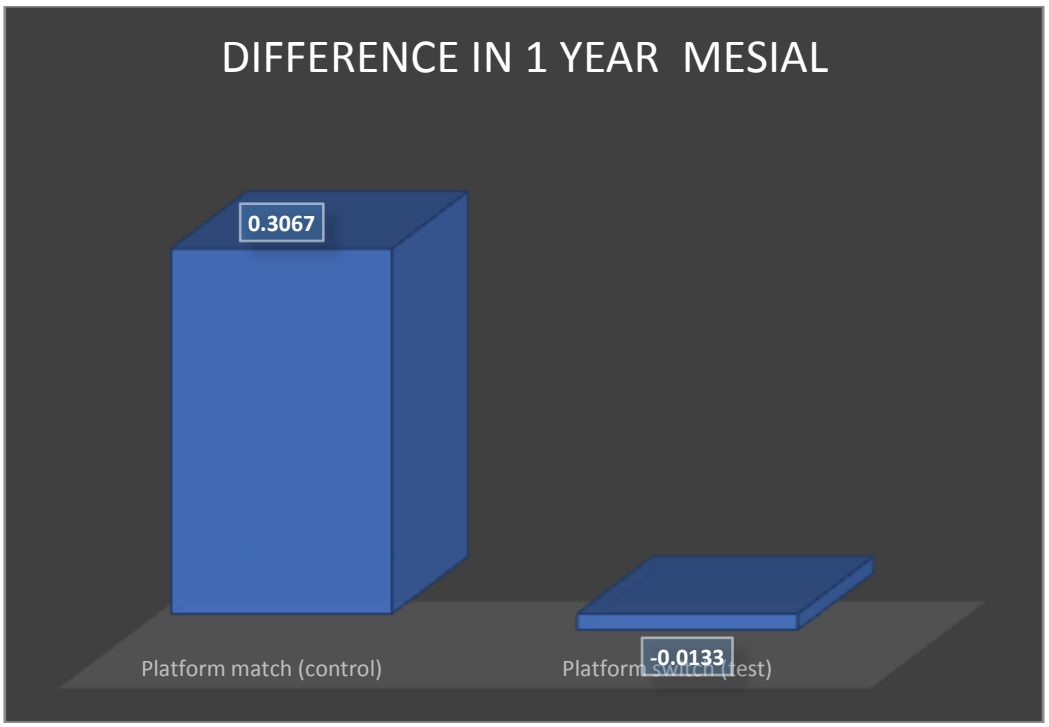
Graphs



Graph 1: Comparison of Mean bone loss values of mesial side at different time intervals between platform match & platform group



Graph 2: Difference in bone loss at mesial side at the end of 1 year of platform match & platform switch group.

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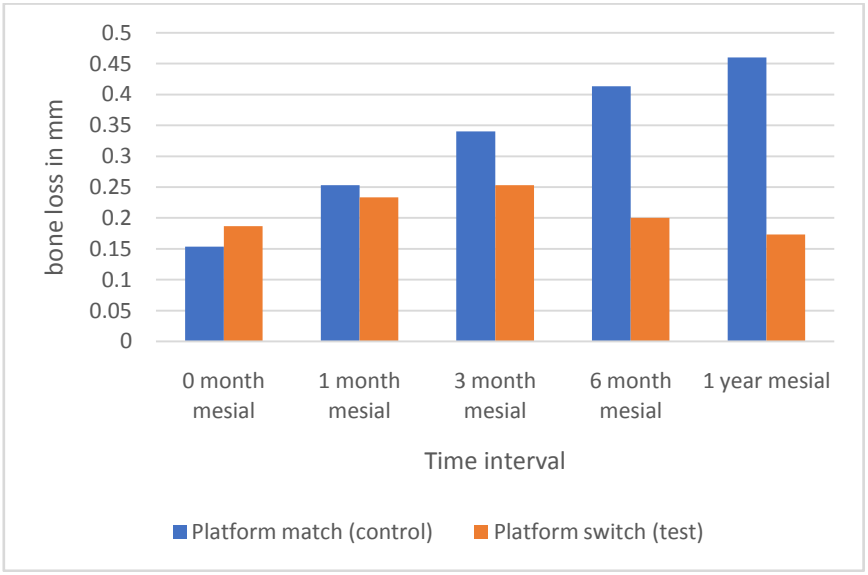
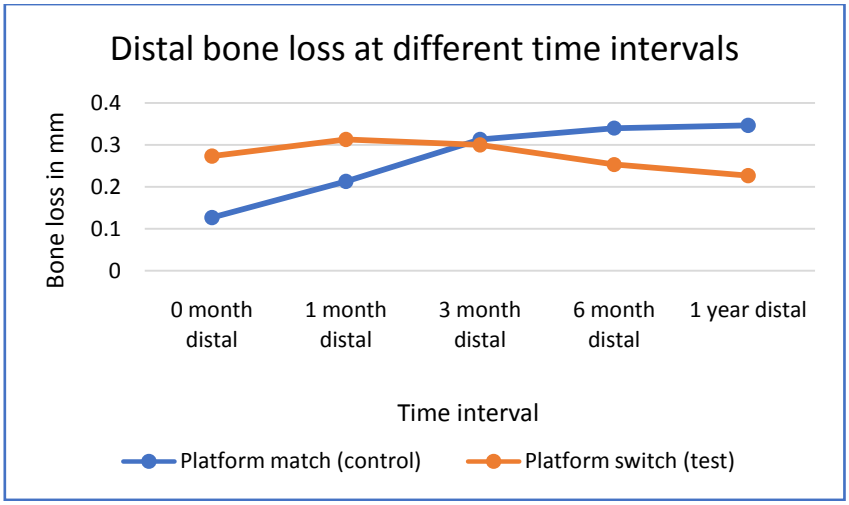
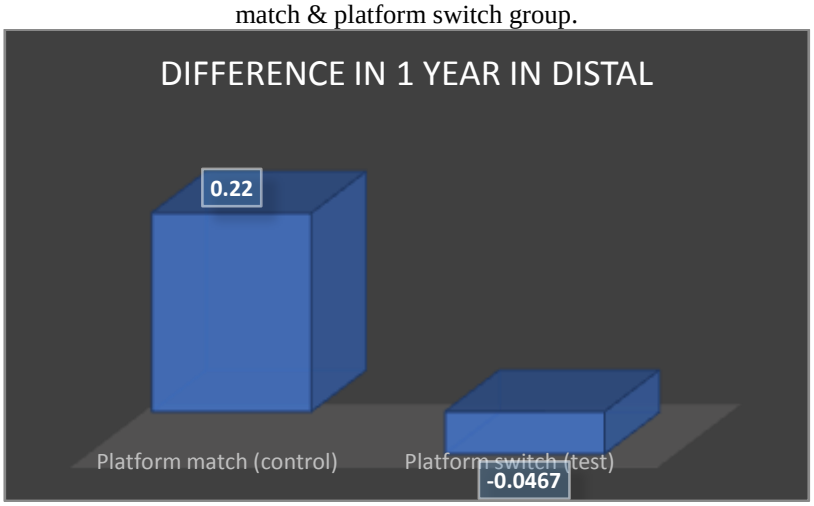


Graph 3 - Mean scores of mesial MBL of two groups in each time period



Graph 4: Comparison Of Mean Bone Loss Values of Distal Side at Different Time Intervals between platform match & platform switch group.



Graph 5: Difference in bone loss at distal side at the end of 1 year of platform match & platform switch group.

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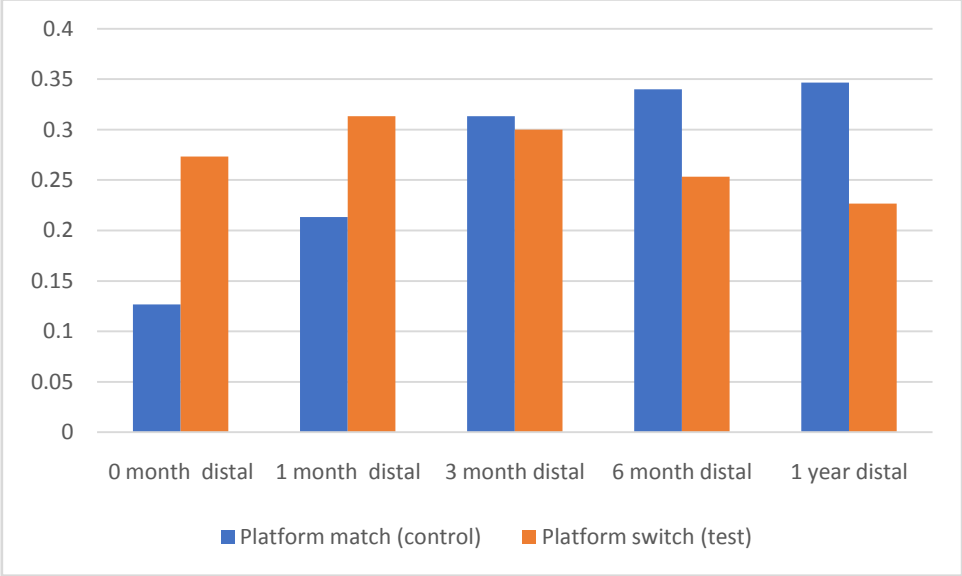

Graph 6 - Mean scores of distal MBL of two groups in each time period

Tables

Table 1: crestal bone loss values in platform match (control group)

				Platform match (control group)									
Sr no	Implant site		Radiographic assessment after loading (in mm)										
			Baseline		1 month		3 month		6 month		1 year		
			Mesial	Distal	Mesial	Distal	Mesial	Distal	Mesial	Distal	Mesial	Distal	
1	36		0.2	0.2	0.4	0.2	0.5	0.5	0.5	0.5	0.5	0.5	
2	46		0	0	0.2	0.2	0.3	0.5	0.5	0.5	0.7	0.5	
3	36		0.1	0	0.1	0.2	0.1	0.1	0	0	0	0	
4	16		0	0	0	0	0.1	0.1	0.2	0.1	0.2	0.1	
5	17		1.4	1	1.4	1	1.2	1	1.2	0.9	1.2	0.9	
6	26		0	0	0.2	0.1	0.2	0.3	0.3	0.3	0.4	0.3	
7	37		0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.4	
8	36		0	0	0.1	0.2	0.2	0.2	0.4	0.3	0.4	0.3	
9	46		0	0	0	0	0	0	0	0	0.1	0.1	
10	46		0.2	0.2	0.3	0.2	0.4	0.2	0.4	0.3	0.4	0.3	
11	27		0	0	0.2	0.1	0.3	0.3	0.5	0.3	0.5	0.3	
12	47		0	0	0.1	0.2	0.5	0.3	0.8	0.5	0.8	0.5	
13	47		0.1	0.2	0.2	0.2	0.4	0.2	0.4	0.3	0.5	0.3	
14	26		0	0	0.2	0.2	0.3	0.4	0.3	0.4	0.3	0.4	
15	36		0.2	0.2	0.3	0.2	0.4	0.3	0.4	0.3	0.4	0.3	

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Table 2: Crestal Bone Loss Values in Platform Switch (Test Group)

				Platform switch (test group)							
Sr no	Implant site		Radiographic assessment after prosthetic loading (in mm)									
			Baseline		1 month		3 month		6 month		1 year	
			Mesial	Distal	Mesial	Distal	Mesial	Distal	Mesial	Distal	Mesial	Distal
1	46		0.6	1.2	0.9	1.5	0.9	1.5	0.6	1.2	0.5	1.1
2	36		0	0.5	0.2	0.5	0.2	0.3	0.1	0.2	0.1	0.2
3	46		0.5	0.9	0.5	0.9	0.5	0.8	0.5	0.6	0.4	0.6
4	36		0.5	0.3	0.5	0.3	0.6	0.5	0.5	0.5	0.3	0.3
5	37		0.3	0	0.1	0	0.1	0	0	0.1	0	0
6	16		0	0	0.1	0.1	0.3	0.2	0.2	0.2	0.2	0.2
7	36		0	0	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2
8	46		0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
9	35		0	0.4	0.2	0.5	0.2	0.3	0.2	0.2	0.2	0.2
10	45		0.2	0	0.2	0.1	0	0	0	0	0	0
11	36		0.3	0.2	0.3	0.2	0.3	0.3	0.3	0.2	0.3	0.2
12	46		0	0	0	0	0	0	0	0	0	0
13	16		0	0	0.1	0.1	0.3	0.2	0.2	0.2	0.2	0.2
14	16		0	0	0	0	0	0	0	0	0	0
15	36		0.2	0.5	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1