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## Effect of varying horizontal mismatched implants on crestal bone level and peri-implant soft tissue: An *in vivo* study

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### Abstract

**Purpose:** To evaluate the effect of varying horizontal mismatched implant-abutment interface on hard and soft tissue following one-stage dental implant placement in mandibular posterior region.

**Materials and Methodology:** A Prospective clinical study was conducted across 20 subjects (8 males and 12 females) based on the inclusion and exclusion criteria. Subjects were broadly divided into two groups with 10 dental implants in each i.e. implant with 0.3-0.6 mm implant-abutment interface horizontal mismatch and implant with 1-2 mm implant-abutment interface horizontal mismatch. Single stage protocol was performed. The subjects were evaluated radiographically at baseline (at time of implant placement) and 2 month, 4 month and 6 month post-operatively for crestal bone changes and soft tissue evaluation.

**Result:** The present study showed that on both proximal sides, the mean change from 0 month, 2 months, 4 months and 6 months for 1-2mm mismatch at bone implant contact was significantly lower than with 0.3-0.6mm mismatch (+0.07 against +0.26 mm on mesial side and +0.15 against +0.33mm on distal side at 6 months). This indicates that the loss of bone during the six-month period was significantly lower with 1-2mm mismatch compared to with 0.3-0.6mm implant-abutment interface mismatch. Therefore, the results of the present study confirms the hypothesis that increased mismatch at bone implant contact result in lesser crestal bone reduction.

Study also shows the comparison of probing depth (PD) and bleeding on probing (BOP) at different time interval between group with implant-abutment interface mismatch of 0.3-0.6 mm and group with implant-abutment interface mismatch of 1-2 mm. There was no statistically significant difference in PD and BOP of both the groups at baseline and 2<sup>nd</sup>, 4<sup>th</sup> and 6<sup>th</sup> month.

**Conclusion:** It was concluded from present study that use of 1-2mm implant abutment horizontal mismatch interface, preserve more periimplant crestal bone and produces more favourable soft tissue response than 0.3-0.6mm implant abutment horizontal mismatch interface.

**Keywords:** abutment connection, dental implants, platform switching, crestal bone loss

### Introduction

Implants provide a means of support for dental prosthesis without depending on the remaining teeth as the potential abutment teeth are not traumatized and endodontic intervention is not required. It provides a permanent long term functional and aesthetics advantage to many clinical circumstances that lacked solutions prior to the routine use of implant therapy [1]. Traditionally, to minimize implant failures and to better ensure osseointegration, dental implants were inserted following a two stage protocol. Implants were completely submerged under the soft tissues and left to heal for a period of 3 to 4 months in mandibles and 6 to 8 months in maxilla. In fact, primary implant stability and lack of micro-movements are considered to be two of the main factors necessary to achieve a predictably high success rate of osseointegrated dental implants [2]. A successful osseointegrated dental implant is anchored directly to bone. However, in the presence of movements during healing, the implant may be encapsulated by soft tissues instead, similar to what happens with non-union bone fractures, causing the failure of the implant [3].

Some authors developed dental implants to be used with a one-stage procedure with flaps sutured around the polished neck of the implants avoiding the need for a second surgical intervention.<sup>4</sup> Subsequent controlled clinical trials,<sup>5</sup> comparing implants placed according to a one versus two-stage procedure also suggested that implants placed with a one-stage approach

may achieve a high degree of success as it avoids one surgical intervention, shortens treatment time and enhances the ability of peri-implant tissue healing to create favourable soft and hard tissue integration.

After implant placement, bone remodelling occurs in peri-implant area which is the reason for changes in crestal bone height. Modifying the implant abutment junction geometry (by connecting an abutment with diameter smaller than the implant platform) appeared to reduce the crestal bone remodelling. A number of investigators have found that there is significantly less marginal bone loss around platform-switched implants than around implants with a traditional implant-abutment junction geometry.

Greater crestal bone loss has never been observed with platform-switched restorations than would be expected with dental implants restored conventionally with matching diameter components/regular implants [6]. Platform switched implants show significantly greater papilla height than in a non-platform switched group [7, 8]. Greater number and length of connective tissue fibers was found around implants which incorporated a non-flared neck with reduced diameter abutments than other designs [9].

Conclusively earlier studies showed better marginal bone level maintained by using platform switched implants than regular implants, but did not quantified the relationship between dimension of horizontal mismatched platform and crestal bone level changes. Hence, this study was planned to assess the effect of varying horizontal mismatched implant-abutment interface on crestal bone level and peri-implant soft tissue following one-stage dental implant placement.

### Materials and Methods

A prospective clinical study was done involving the subjects selected from the Out Patient Department of Prosthodontics and Crown & Bridge, and Oral Implantology, H.P. Government Dental College, Shimla. The subjects were evaluated based on chief complaints requiring replacement of missing mandibular posterior teeth.

### Study population

After meticulous clinical and radiographic examination, 20 subjects (8 males and 12 females) were included in the study based on the inclusion and exclusion criteria.

### Inclusion criteria

1. Subjects consented to participate in the study.
2. Age - 18 years and above.
3. Subjects with missing tooth in mandibular posterior region.
4. Subjects with good oral hygiene.
5. Subjects with adequate bucco-lingual, mesio-distal and inter-occlusal space at the site of implant placement.

### Exclusion criteria

1. Subject with presence of infection around site of implant placement.
2. Subjects with any dental or medical condition that would interfere with the soft tissue and bone healing.
3. Parafunctional habits like bruxism.
4. Poor oral hygiene.
5. Previous history of radiotherapy in head and neck region within one year.
6. Subjects on medication known to interfere with wound and bone healing.

### Study groups

A total of 20 dental implants were placed (10 dental implants per group) in subjects requiring replacement of mandibular posterior teeth. Selected subjects were grouped on the basis of amount of implant-abutment interface mismatch as:

Group I: With implant-abutment interface mismatch of 0.3mm-0.6 mm.

Group II: With implant-abutment interface mismatch of 1mm-2mm

### Randomization

Randomization of study subjects was done using lottery method. Each participant was told to randomly choose from identical slips for different groups.

### Methodology

A detailed medical and dental history of each subject was assessed along with preoperative photographs and radiographs. Surgical area selected for dental implant placement was evaluated clinically for width and height. A metal sphere of predetermined diameter (4mm) was used to calibrate length and diameter of dental implant. Other investigations such as complete haemogram, and blood sugar test were furnished. A complete oral prophylaxis along with prescription of 0.2% chlorhexidine gluconate mouth rinse, twice daily for a period of 15 days before dental implant placement was advised.

### Diagnostic records obtained

The diagnostic impression was made in irreversible hydrocolloid and diagnostic cast was prepared and mounted on mean value articulator. For each patient, an individual customized film holder was fabricated to ensure a reproducible radiographic analysis.

### Radiographic records obtained

Preoperative radiographic records were made to assess the bone, and proximity to anatomical landmarks and relation of tooth /teeth to adjacent side.

#### i) Orthopantomograph (OPG)

Pre-operative digital OPG was obtained for each subject with Digital Panoramic Radiographic Unit. A metal sphere of predetermined diameter (4mm) was used to calibrate length and diameter of dental implant to be placed. The OPG obtained was then used to calibrate the dental implant length. The measurements were made with the help of Digimizer Image Analysis, MedCalc Software, Version 4.3.5.0.

#### ii) Intra oral periapical (IOPA) radiograph

This involves:

##### a. Fabrication of the vinyl polysiloxane JIG

A Vinyl Polysiloxane putty jig was fabricated to standardize the radiographic film holder (Rinn XCP) for each subject, in term of, angulations and position of the film relative to the X-ray beam. Vinyl Polysiloxane Putty was mixed and attached to film holder. The film holder was seated into subject's mouth at a correct angulation and subject was instructed to bite on putty to get indentation of maxillary teeth. Then, this occlusal jig was used to take radiographs at subsequent visits during the follow-up visits to measure/assess bone level changes.

### **b. Procedure for taking IOPA X-Ray**

The periapical radiographs were made with the long cone paralleling technique with radiographic film holders (Rinn XCP) using putty jig for the standardization of the projection & film placement to take radiographs at subsequent visits during the follow-up visits. The subject was seated in upright position. The IOPA film was placed in film holder and it was seated properly in subject's mouth using the putty index. The x-ray tube head was placed against localizing ring of the film holder.

### **Surgical procedure**

Following steps were followed during surgical procedure:

1. Properly sterilized surgical instruments were arranged on a surgical trolley. Subject was seated in the dental chair and prepared following the standard guidelines for asepsis.
2. Surgical phase was carried out under local anesthesia. Inferior alveolar nerve block, Lingual nerve block and long buccal nerve block was administered using Lignocaine and Adrenaline Injection I.P. 1:80000.
3. After confirming the effectiveness of local anesthesia, mid-crestal incision was given using surgical blade no.15. The incision was extended to the mesial & distal teeth as crevicular incision. Vertical releasing incisions (anterior & posterior) or only anterior were given on adjacent teeth.
4. Facial and lingual full mucoperiosteal flaps were reflected with the help of mucoperiosteal elevator first using sharp end and then with blunt end to provide adequate access for osteotomy site preparation.
5. Osteotomy site preparation was initiated with pilot drill along the buccal and lingual wall of the residual alveolar ridge. Osteotomy preparation was completed by sequential drilling till the final length of the dental implant. Paralleling tool was used to check parallelism with adjacent teeth. After determining the final length of osteotomy, width of the osteotomy was increased with drills gradually increasing in diameter.
6. A manual dental implant connector was used to hold the selected dental implant. With the help of torque wrench, dental implant was positioned at the osteotomy site approximating the cervical collar of dental implant with the crestal bone margin. At the end, healing abutment of predetermined size to respective group were placed thereafter.

The surgical site was properly cleaned and irrigated with 0.9% saline solution. 3-0 black braided silk was used for interrupted suture. Sutures were made water tight and knot was tied away from the incision line.

### **Follow up**

Post-operative instructions were given to the patients regarding diet, oral hygiene maintenance. Subjects were instructed to have a soft diet and to avoid chewing in the treated area until the suture removal. Oral hygiene at the surgical site was limited to soft brushing for the first 2 weeks. Regular brushing in the rest of the mouth and rinse with 0.12% chlorhexidine were prescribed for 2 weeks. Thereafter, conventional brushing and flossing were permitted. Subject were recalled at 2, 4 and 6<sup>th</sup> month for radiographic evaluation of bone changes and soft tissue evaluation.

### **Maintenance**

- Subjects were advised to brush properly and to use interdental brush and flossing. Subjects were kept on regular follow ups.
- After implant placement it was left for osseointegration following early loading protocols that is 2 months for mandible and 3 months for maxilla (Ozan) and abutments of predetermined size to respective group were placed thereafter.
- After abutment placement the impression was made by polyvinylsiloxane material using direct impression technique. Impression was then poured in die stone to fabricate the cast. After cast fabrication die cutting was done and wax pattern fabricated, metal casting was then fabricated from investing and casting of this wax pattern.
- Metal try in was then made followed by shade selection. Final prosthesis was fabricated and then tried in patient's mouth and occlusion adjusted, after final trial the prosthesis was cemented with the help of Glass ionomer cement type I (luting).

### **Follow Up**

For 2<sup>nd</sup> month, 4<sup>th</sup> month, and 6<sup>th</sup> month postoperatively each subject was evaluated for changes in crestal bone level evaluated on mesial and distal side of the dental implant with the help of intra-oral peri-apical (IOPA) X-rays. Soft tissue assessment including probing depth (PD), bleeding on probing (BOP) and inter dental papilla was clinically evaluated.

Furthermore, digital periapical standardized radiographs were taken to control the perfect adaptation of the abutment on the implant. Every 2 months after the final restoration, clinical assessments were performed in order to evaluate periodontal parameters at implants and neighbouring (mesial and distal) teeth and periapical standardized digital radiographs were taken in order to evaluate marginal bone level alterations after loading.

A computerized measuring technique was applied to all periapical radiographs. Evaluation of the marginal bone level around implants was performed using an image analysis software. The software calculated bone remodelling at the mesial and distal aspects of the implants. Because each implant was inserted at the bone crest level, the distance was measured from the mesial and distal margin of the implant neck to the most coronal point where the bone appeared to be in contact with the implant. For each implant, mean values of mesial and distal records were used.

### **Measurement of crestal bone level on mesial and distal side of dental implant**

The Intra oral radiographs obtained by using a paralleling technique were digitized. The radiographs were obtained at 0 month i.e. immediately after dental implant placement and at 2<sup>nd</sup> month, 4<sup>th</sup> month and 6<sup>th</sup> month. To obtain a reproducible data, a definitive reference line was marked i.e. the first thread of dental implant as it was static, permanently visible and easy to locate on all radiographs. The measurements were made to the nearest of 0.01mm with the help of Digimizer Image Analysis. Prior to analysis, the images were calibrated geometrically based on dental implant length.

### **Periimplant soft tissue assessment**

#### **(A) Probing depth (PD)**

Distance between gingival margin and base of sulcus is known as probing depth. Probe is particularly designed for

gentle manipulation of the very sensitive soft tissue around the dental implant. Periimplant soft tissue was probed to determine pocket depth. The probe was inserted between the implant and gingival, and sulcus depth or pocket depth was noted against the measuring lines in mm. Direction of probing during insertion was kept parallel to long axis of implant.

### (B) Bleeding on probing (BOP)

It was measured on mesial, distal, buccal and lingual surface of concerned tooth. After probing the surface, a waiting period of 30 seconds was given to allow the bleeding become visible.

Scoring criteria-

- 0- No bleeding
- 1- Bleeding present

### (C) Interdental papilla (IDP)

Papillary gingiva is the gingival portion between the teeth. Presence and absence of inflammation on each papillary unit was recorded.

Scoring criteria-

- 0- Normal, no inflammation
- 1- Mild papillary enlargement
- 2- Obvious increase in size of gingival papilla, bleeding on pressure.
- 3- Excessive increase in size with spontaneous bleeding
- 4- Necrotic papilla
- 5- Atrophy and loss of papilla

### Analysis of data

Different statistical methods were applied in this study which include Paired T test, Arithmetic mean, Standard deviation, Mann Whitney U test, Chi-square test, Repeated measures ANOVA, Independent sample t-test, Cochran Q test, Friedman test

Steps:

- As per the null hypothesis, assume that there is no real difference between the means of two samples.
- Find the difference in each set of paired observations before and after ( $X_1 - X_2 = X$ )
- Calculate the mean of the differences ( $\bar{X}$ )
- Work out the standard error of mean,  $SE = SD/\sqrt{n}$
- Determine 't' value, 't' =  $\bar{X} /$  standard error of difference
- Find the degrees of freedom (n-1)
- Refer 't' table and find the probability of 't' corresponding to n-1 degree of freedom.
- If the probability is more than 0.05, the difference observed has no significance, because it can be due to chance.

### Decision criterion

p-value < 0.05 indicates a significant difference between two groups.

Each subject was evaluated for changes in crestal bone level evaluated on mesial and distal side of the dental implant with the help of intra-oral peri-apical (IOPA) X-rays. Soft tissue assessment including probing depth (PD), bleeding on probing (BOP) and inter dental papilla was clinically evaluated.

### The measurements were recorded at:

- a. Immediate post-operative.
- b. 2 month following dental implant placement.
- c. 4 month following dental implant placement.
- d. 6 month following dental implant placement.

### Discussion

The aim of this study was to assess marginal bone level alterations radiographically and periimplant soft tissue clinically in implants restored according to the platform-switching concept using two different mismatched implant-abutment diameters compared with each other.

The present study showed that on both proximal sides, the mean change from 0 month, 2 months, 4 months and 6 months for 1-2mm mismatch at bone implant contact was significantly lower than with 0.3-0.6mm mismatch (+0.07 against +0.26 mm on mesial side and +0.15 against +0.33mm on distal side at 6 months). This indicates that the loss of bone during the six-month period was significantly lower with 1-2mm mismatch compared to with 0.3-0.6mm implant-abutment interface mismatch. Therefore, the results of the present study confirms the hypothesis that increased mismatch at bone implant contact result in lesser crestal bone reduction.

It is observed that the crestal bone lateral to implants with the circumferential dimensional difference, appears to respond differently than what is typically observed when implants are restored with matching diameter components. What is typically observed, but with some variance is that when matching-diameter implant and restorative components are used in the fabrication of the definitive restoration, the crestal bone contacting the implant normally remodels 1.5 to 2.0 mm apically, to approximately the first implant thread. The same result is observed radiographically when an implant is uncovered and a matching-diameter healing abutment is attached and remains in place for several months.

This observation indicates that the crestal bone remodeling process is not dependent upon an implant being placed into function, but rather its exposure to the oral environment. In contrast, when smaller-diameter components are placed on wider-diameter implant platforms, the amount of crestal bone remodeling is noticeably reduced, with many platform-switched restored implants exhibiting no vertical loss in crestal bone height. There appear to be two results of the horizontal inward repositioning of the implant-abutment interface. First, with the increased surface area created by the exposed implant seating surface, there is a reduction in the amount of crestal bone resorption necessary to expose a minimum amount of implant surface to which the soft tissue can attach. Second, and perhaps more important, by repositioning the implant abutment junction inward and away from the outer edge of the implant and adjacent bone, the overall effect of the abutment inflammatory cell infiltrate on the surrounding tissue may be reduced, thus decreasing the resorptive effect of the inflammatory cell infiltrate on crestal bone [5, 8, 9].

It is further suggested that platform switching repositions the abutment inflammatory cell infiltrate further away from crestal bone. As a consequence, the reduced exposure and confinement of the platform switched abutment inflammatory cell infiltrate may result in a reduced inflammatory effect within the surrounding soft tissue and crestal bone.

However, it is important to note that to benefit from the platform-switching bone preservation technique, reduced-diameter components, beginning with the healing abutment, must be used from the moment that the implant is exposed to the oral environment, because the process of biologic width formation begins immediately following exposure to the oral environment. Thus, whether an implant is placed using a one- or two-stage surgical procedure, the first component placed on the implant must be of a smaller diameter if a horizontally

repositioned biologic width is to be accomplished. Similar findings also observed [10] tendency toward the positive impact of platform switching on crestal bone preservation. An Abutment-Implant collar diameter mismatch should be more than or equal to 0.4 mm, so as to have a significant influence on crestal bone loss.

To achieve a good functional and esthetic results with implant restoration, it is important to consider the biologic principles of both soft and hard tissues around an implant. In this regard, the presence of good amount and quality of bone around the implant, especially the crestal bone plays a very important role [11].

Early peri-implant bone loss has been commonly observed as a consequence of physiologic bone remodelling during initial phase of healing. Hence, the crestal bone resorption is considered normal till certain extent. In a two piece implant system, crestal bone resorption to first coronal thread is commonly observed after abutment attachment and loading [12]. After functional loading, implant averages approximately 1.5 mm of bone loss in the first year and at least 0.2 mm per year thereafter [13]. This tendency of crestal bone to naturally adjust can affect both the function and esthetics of the implant [12].

Crestal bone provides crucial support for the facial gingival marginal tissue and papillae, and both are essential for sustaining esthetic restorations over the long term. The use of platform-switched implants appears to be an important element in any strategy for achieving sustainable esthetics [14]. Biological width formed by the implant– abutment interface was attributable to the micro-gap located at the edge of the interface. In the implant restored with the platform switching protocol, in fact, 0.85mm of the biological width extended horizontally from the abutment to the edge of the implant collar and only the remaining part extended apically to this region. The slightly better behavior obtained by platform-switched restored implants seems to be strongly correlated to the less bone loss occurred in this kind of restoration and the interproximal alveolar bone crest preservation [15-17].

Under the guidelines of the present study, the results suggest that use of 1-2mm implant abutment horizontal mismatch interface, preserve more periimplantcrestal bone and produce more favourable soft tissue response than 0.3-0.6mm implant abutment horizontal mismatch interface.

**Summary and Conclusion**

The use of osseointegrated dental implants as a foundation for prosthetic replacement of missing teeth has become routine clinical practice. Stability of the peri-implant hard and soft tissues and adequate long-term maintenance are fundamental to success. Management of bone resorption is important in achieving better esthetic and functional outcomes. Platform switching is a method of preserving crestal bone around the top of wide diameter implants and seemingly altering the starting point from which the crestal bone resorption occurs. The outer part of the implant platform, providing a horizontal titanium surface available for soft tissue attachment, may reduce marginal bone remodelling normally involved in the biological width formation. Moreover, it has been suggested that the horizontal inward repositioning of the implant abutment interface can move both inflammatory cell infiltrate and area of maximum biomechanical stress away from crestal bone.

It can be concluded from present study that use of 1-2mm implant abutment horizontal mismatch interface, preserve more periimplantcrestal bone than 0.3-0.6mm implant

abutment horizontal mismatch interface. Implant with 1-2mm implant abutment horizontal mismatch interface produces more favourable soft tissue response at the level of implant abutment connection than implant with 0.3-0.6mm implant abutment horizontal mismatch interface.



**Fig 1:** Materials Used In The



**Fig 2:** Surgical armamentarium



**Fig 3:** Pre-operative frontal



**Fig 4:** Preoperative right lateral



**Fig 5:** Preoperative left lateral



**Fig 6:** Preoperative intraoral view



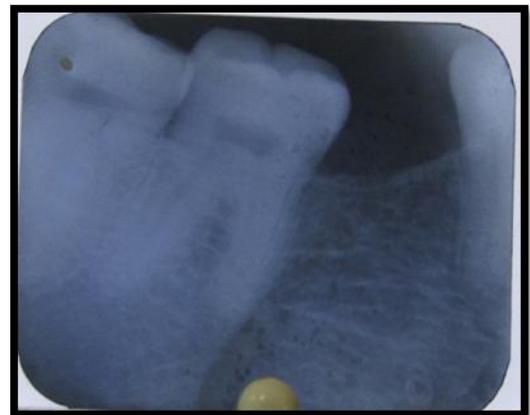
**Fig 7:** Preoperative intraoral mandibular view



**Fig 8:** Preoperative intraoral maxillary occlusal view



**Fig 9:** Orthopantomogram with steel ball 5mm



**Fig 10:** IOPA X ray with 5mm steel ball



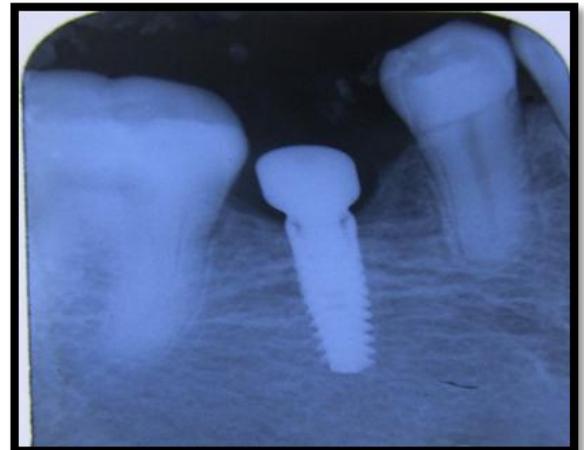
**Fig 11:** Crestal incision and flap raised



**Fig 15:** Healing abutment placed followed by flap



**Fig 12:** Osteotomy site prepared



**Fig 16:** Immediate postoperative iopa



**Fig 13:** Paralleling tool used to check parallelism



**Fig 17:** Surgical site after one month



**Fig 14:** Dental implant placement in osteotomy



**Fig 18:** Abutment placed over implant



**Fig 19:** Impression for implant prosthesis



**Fig 20:** Final prosthesis

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