RESEARCH ARTICLE

IMMEDIATE LOADING OF SINGLE TOOTH IMPLANT IN POSTERIOR MANDIBLE: A CLINICO-RADIOGRAPHIC EVALUATION

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ABSTRACT

AIM: The replacement of teeth with dental implants, by traditional protocols, is been done in multiple stages. It includes a dormant healing period of 3-6 months after the first implant surgery to allow sufficient time for the healing and the osseointegration. The aim of this study was to evaluate the performance of single tooth implant subjected to load immediately after placement in posterior region of mandible.

Materials and Methods: Single-tooth implants were placed in well healed extraction sites in ten adult patients. Temporary prefabricated acrylic resin crown was cemented with minimal contact in maximum intercuspation replaced by a ceramometal crown six months after the implant placement. Radiographic and clinical examinations were made at baseline and at 3, 6, 9, and 12 months. Cortical bone response and peri-implant mucosal responses were evaluated.

Results: The overall results of this study reported a 100% success rate, as 10 out of the 10 implants exhibited the successful osseointegration. Discussion: Clinical research has shown that immediate loading is a possible treatment modality. The immediate functional loading of implants placed in this study resulted in bone adaptation to loading. A satisfactory success rate with positive tissue responses was achieved.

Conclusion: It was reported that immediate loading of a single-tooth implant in the posterior region of mandible may be a viable treatment option with an ensured esthetic outcome.

Key words: Dental Implants, Immediate Loading, Osseointegration, Implant success criteria

INTRODUCTION

Successful Implant-based dental treatment is associated with rigid protocols advocating the lengthy periods of undisturbed healing. As per the traditional protocols, the dental implant is inserted and left for 3-6 months to allow the osseointegration. A stress-free healing period is a prerequisite for successful Implant placement according to the protocol of Branemark and colleagues.[1] Technological advances are changing the concepts in implantology, thereby replacing the traditional protocols such as ‘two-step surgical protocol’ by the ‘one-step surgical protocol’ and the immediate loading. *Immediate loading* means

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delivering a prosthetic restoration (temporary or definitive) immediately after the placement of an implant, or within 48 hours following the surgery.[2] It can be functional or nonfunctional wherein, *immediate functional loading* (IFL) refers to the use of a temporary or definitive prosthesis seated the same day as the surgery or shortly thereafter with the occlusal contact; in contrast to that, *immediate nonfunctional loading* (INFL) refers to the prosthesis with the occlusal contact with the opposing arch. [2]

The main advantage in INFL is the immediate restoration of the missing tooth/teeth by the temporary restoration not being in occlusion, serves the esthetic purpose and guides the sculpting of the soft tissues; at the same time it reduces the risk of biomechanical overloading because of parafunctional habits.[2,3]

Earlier, it was thought that micromotion resulting from immediate implant loading can result in fibrous encapsulation of the implant but, it was found that the density of bone around immediately loaded implants was higher than those loaded after a specific delay.[4-9] High primary stability of the implants permits better bone regeneration and peri-implant tissue differentiation.[10-11] Recent studies on immediately loaded implants have found that there was close contact between mineralized bone and the implant surface, with no fibrous tissue at the interface.[12-15]

The aim of this study was to evaluate the treatment outcomes of single tooth replacement with implant retained artificial crown with 1-stage surgical procedure and immediate loading clinically and radiographically.

MATERIALS AND METHODS

The study was conducted in the Implantology section of the Department of Prosthodontics at Teerthanker Mahavir Dental College and Research Center. All the principals were followed as stated in the Declaration of Helsinki.[16]. A permission was retrieved from the institutional ethical board.

Totally 64 patients visited the department with the intension of placing an implant with single tooth missing oral situation. After a thorough clinical examination and systemic and previous dental history only 19 patients were fit to undergo implant therapy surpassing the biological and technical limitations. There was a dropout of another 10 patients due to the inability to afford the implant cost and the inconvenience of the time scheduling. Finally, a total of nine partially edentulous patients (2 males, 7 females) between the age group of 23 and 42 years (mean 30.11 years) were enrolled for the study on the basis of study criteria. The study criteria included good oral hygiene maintenance, one or more missing teeth in the posterior zone (premolar and molar region), adequately healed and remodeled ridge, sufficient residual bone volume to receive implants (at least 4.2 mm in diameter and 10 mm in length), and implant placement torque > 35 Ncm, periodontically healthy adjacent teeth, absence of supraeruption of opposite tooth and willingness to undergo restoration with dental implants and participate in prospective study. While the criteria excluded severe bruxism, insufficient bone volume, smoking more than 20 cigarettes/day, excessive consumption of alcohol, medically compromising conditions which prohibit implant surgery, such as stroke, recent infarction, severe bleeding disorders, diabetes, osteoporosis, localized radiation therapy of the oral cavity, chemotherapy,

liver pathologies, blood diseases, kidney diseases, immunosuppression, taking corticosteroids, pregnant or lactating , inflammatory and autoimmune diseases of the oral cavity, poor oral hygiene, implant placement torque <35 Ncm.

All the patients were well informed about the treatment procedure, a signed consent was taken by the patients.

An ADIN implant system (*Touareg*, ADIN Dental Implant Systems Ltd. Israel) was used for this study. The *Touareg Spiral Implant System* offers a unique, strong and solid conical-hex connection. The conical-hex connection enables an easy placement in all the indicated regions of upper and lower jaw. The Morse Taper connection minimizes micro movements between the implant and abutment. *Touareg Spiral Implant System* is a tapered core implant with a spiral tap, promoting immediate stability. With its unique tip and double lead thread design (2 x 1.2mm), this implant slices through bone unlike conventional self-tapping implant, which scrapes the bone away as it taps by condensing the bone during implant placement. *Touareg* implants can be placed at different angles providing exceptional primary stability and optimal restorative orientation, along with improved esthetics with a better loading distribution.

Pre-implant documentation was obtained for treatment planning purposes.(Fig.1 & Fig.2) Radiovisiographs were obtained to evaluate the alveolar ridge and the position of inferior alveolar nerve. Determination of the mucosal thickness was performed by the bone gauge at the site of implantation. The mucosal thickness and bone quantity at the implantation site were analyzed on a split-die cast. A clear acrylic resin surgical drill guide were prepared to facilitate correct implant placement. The implants placed here did not require any extensive surgical procedures such as the bone augmentation or expansion; as the implant sites were given the consideration where the bone regeneration was efficient.

Surgical Procedure

The implants were installed according to the standard protocol.[17, 18] The patients were instructed to do the mouth rinse (chlorhexidine 0.12%) prior to the surgery. Under local anesthesia (Lignocaine with 1:80,000 Adrenaline) a punch cut incision was made at the implant site using the surgical guide(Fig..3). A surgical drill guide/template was used for the precise placement of the pilot drill. The angulation was checked with the paralleling pin, both clinically and radiographically. The osteotomy was then diametrically enlarged to the desired width. The appropriate position of the implant neck in both the vertical and horizontal dimension was decisive. The implant neck was positioned at the crestal bone level or slightly submerged(Fig.4). It was made sure that a minimum torque of 35Nm was obtained while screwing in the implant with Torque ratchet, as this was the prerequisite for immediate loading. The abutment was then attached to the implant with the screw provided in the kit using a torque controller with a force of 25 Ncm(Fig.5).

The medication prescribed to the patients was as, Amoxicillin 500mg TID, Metronidazole 400mg TID and a Diclofenac + Paracetamol preparation BID, along with chlorhexidine 0.12% mouth rinse.

During the surgery, patients who fulfilled the criteria of achieving a minimum torque of 35-40Nm was considered positively in this study, as that amount is a pre-requisite

for immediate loading. These criteria of patient selection were in accordance to those given by Nkenke and Fenner [19]

Prosthetic Procedure

After the surgical intervention the prefabricated temporary acrylic resin crown was relined with an auto polymerizing acrylic resin and was cemented to the abutment(Fig.6) with the temporary cement (Temp Bond, Kerr Co., USA). The excess material was carefully removed. The provisional crown was kept out of contact or at minimal contact in centric relation as well as at lateral excursions. Six months after the implant placement the temporary crown was removed and a permanent crown was cemented(Fig.7 & Fig 8). This crown was designed with the same occlusal and functional pattern as present on the corresponding contralateral natural tooth and permanently cemented using a zinc-phosphate cement. The interproximal contacts were designed as broader contact areas to distribute the forces of mastication and provide support.

A regular follow up was maintained for all the study patients over a period of twelve months. The parameters included in the study were recorded five times, i.e. in 1st month, 3rd month, 6th month, 9th month and 12th month.

As the implant success depends on the availability of favorable clinical conditions care has been taken to follow the basic rules. As per the ideal protocol sufficient time (6 months) was provided for osseointegration and for the implants to serve as the prosthetic abutments. The implant quality scale is divided into four groups as shown in Table 1.

Post-operative evaluation of the immediately loaded implants included three parameters to assess the objectives of the study viz.,

1. Implant mobility
2. Soft tissue changes
   a. Peri-implant probing depth
   b. Bleeding index
3. Height of marginal bone loss

Implant mobility and the soft tissue changes were assessed at the delivery of the temporary crown and at every follow-up examination using 2 dental instrument handles placed on the buccal and lingual aspect of the crown.[20] while mean marginal bone levels were assessed radiographically using the standard intra-oral periapical radiographs. To adjust the measurements for magnification error, the following equation was used to determine the corrected crestal bone levels[21]

$$\text{Corrected crestal bone level} = \frac{\text{Measured crestal bone level} \times \text{Actual implant}}{\text{Measured implant length}}$$

RESULTS

Ten implants were placed and immediately loaded with the provisional crowns. Implant mobility was measured by using the implant mobility scale (Table 2). The mobility was measured in the 1st, 3rd, 6th, and 9th month of placement. In the first month of implant placement, 100% (n=10) implants showed absence of any clinical mobility to approximately 500gms force in any direction. In the 3rd , 6th month, and 9th month the implant mobility scores remained rather alike. In the 12th month also, the scores were similar.

The mean probing depth recorded for these 10 implants was calculated and depicted in the graph (Graph I). The values were found to be as, 1.57mm, 1.47mm,1.45mm, 1.42and 1.42mm in the 1st, 3rd, 6th ,9th and 12th month respectively.

The mean of the bleeding scores of all the

implants, recorded at each follow up visit was calculated, the values of which were as, 0.87, 0.89, 0.76, 0.65 and 0.55 in the 1st, 3rd, 6th, 9th and 12th month respectively.(Graph II)

The marginal bone levels were assessed radiographically, using the intraoral periapical radiovisiographs. The height was measured on the radiograph. After eliminating the elongation caused by angulation errors, the level of bone loss was classified into groups of 0.5mm. The resultant data was classified and tabulated. It was found that in the 1st month, all the implants (100%, n=15) showed a negligible bone loss, i.e. within 0.5mm. In the 3rd month, 20% (n=2) of the implants showed bone loss below 0.5mm, and 80% (n=8) showing bone loss of 0.5-1mm. In the 6th month, 80 %(n=14) of implants exhibited a mild loss of bone height of 0.5 to 1mm and 20 % (n=2) had a bone loss of 1.0 to 1.5mm. By the 9th month, 8 implants (80%) had bone loss levels below 1mm and 2 (20%) implants had bone loss levels between 1-1.5mm which persisted even till the 12th month.(Graph III)

DISCUSSION

Barone et al [22] have found that the density of bone around immediately loaded implants to be higher than around those loaded after a delay.

A total of nine patients were selected for the study based on certain inclusion and exclusion criteria. To maintain the standardization of the results, due to the difference in stress patterns for anterior and posterior teeth, the anterior teeth were not considered in the study that might naturally alter the results.

After being loaded immediately with the temporary prosthesis, the patient was kept under observation for next six months. This followed the placement of a permanent porcelain fused to metal restoration, with optimum contact with opposing tooth in a physiologic/functional limits .The six month gap between the temporary and permanent prosthesis carried significance as:

- It played vital role in reduction of micromotion over the freshly placed and loaded implant during its osseointegration period, as it was made sure that the provisional restoration would be out of occlusal contact.
- The temporary prosthesis would allow the post insertion adjustments, if any.
- It would allow sufficient remodeling of the peri-implant soft tissue architecture.
- A temporary restoration would allow easy removal for any clinical examination, if needed.
- The radiolucency of the material (Acrylic) would facilitate convenience and clarity in radiological assessments.

In this study, Mean marginal bone levels were assessed radiographically using the standard Intra-oral Periapical Radiographs. It is essential that the exact amount of bone loss be determined at every follow-up appointment. The present study is based on the method described by Yoo et al [23]. The length of the implant was measured in millimeters on the radiographs ; while the distance between the observed crestal bone and implant-abutment interface was measured at the mesial and distal implant surfaces using radiovisiographs.

The results of this short term clinical study has demonstrated that implants in the posterior mandible may be immediately loaded following their insertion. The success rate achieved was 100% after 12

months post loading. The clinical and radiologic parameters of evaluation of implant success included in our study were implant mobility, peri- implant probing depths, bleeding index, and mean marginal bone levels. All the four parameters appeared to be in healthy limits in all the implants placed, which is in agreement with the findings of other studies, which have prospectively evaluated immediately loaded implants.

Many researchers have described Immediate loading of dental implants for the completely edentulous mandible using either a bar-retained Overdenture or a complete arch implant-supported fixed prosthesis.[24] It has been maintained that splinting of dental implants is required when immediate loading is planned. In this present study, the interproximal contacts have potentially provided this type of stability. Szmukler-Moncler et al [25] stated that there is a range of micro-movement within which implants can still achieve osseointegration. Beyond a certain level of micro-movement, "deleterious micro-movement", fibrous tissue will surround the implant, and osseointegration will not occur.

CONCLUSION

An analysis of the data obtained in course of this study, coupled and compared with data obtained while reviewing literature, directs us to the conclusion that immediate loading of dental implants in the posterior zone of mandible is a highly predictable modality for replacing single missing teeth. However, it is noted that the patient selection plays a pivotal role in the success of immediately loaded dental implants. We recommend further research with a larger sample size and longer follow-up periods to come up before this implant placement protocol can be decisively declared superior to the conventional loading protocols.

The immediately loaded implants osseointegrated successfully. The implants showed absence of any clinical mobility though a minor bone loss was detected in the radiographs. The overall results of this study demonstrate a success rate of 100%, with ten out of the ten immediately loaded implants with the successful osseointegration.

REFERENCES:

1. Brånemark P-I, Hansson BO,Adell R, et al.Osseointegrated implants in the treatment of the edentulous jaw. Experience from a 10-year period. Scand J Plast Reconstr 1977;16:1–132.
2. Degidi M, Piattelli A. Immediate functional and nonfunctional loading of dental implants: A 2- to 60-month follow-up study of 646 titanium implants. J Periodontol 2003;74:225–241.
3. Misch CE.Non-functional immediate teeth in partially edentulous patients: A pilot study of 10 consecutive cases using the Maestro Dental Implant System.Compendium 1998;19(3): 25–36.
4. Piattelli A, Ruggeri A,Trisi P, Romasco N, Franchi M. A histologic and histomorphometric study of the bone reactions to nonsubmerged unloaded and loaded single implants in monkeys. J Oral Implantol 1993;19:314–320.
5. Piattelli A,Trisi P, Romasco N, Emanuelli M. Histological analysis of a screw implant retrieved from man: Influence of early loading and primary stability. J Oral Implantol 1993;19:303–306.
6. Piattelli A, Corigliano M, Scarano A.Microscopical observations of the osseous responses in early loaded human titanium implants: A report of two cases. Biomaterials 1996;17: 1333–1337.

7. Piattelli A, Paolantonio M, Corigliano M, Scarano A. Immediate loading of titanium plasma-sprayed screw-shaped implants in man: A clinical and histological report of two cases. J Periodontol 1997;68:591–597.
8. Piattelli A, Corigliano M, Scarano A, Quaranta M. Bone reactions to early occlusal loading of two-stage titanium plasmasprayed implants: A pilot study in monkeys. Int J Periodontics Restorative Dent 1997;17:163–169.
9. Piattelli A, Scarano A, Paolantonio M. Immediately loaded screw implant removed for fracture after a 15-year loading period:Histological and histochemical analysis. J Oral Implantol 1997;23:75–79.
10. Brunski JB. Biomechanical factors affecting the bone-dental implant interface: Review paper. Clin Mater 1992;10:153–201.
11. Szmukler-Moncler S, Salama H, Reingewirtz Y, Dubruille JH. Timing of loading and effect of micromotion on bone-dental implant interface: Review of experimental literature. J Biomed Mater Res 1998;43:192–203.
12. Degidi M, Petrone G, Iezzi G, Piattelli A. Histologic evaluation of a human immediately loaded titanium implant with a porous anodised surface. Clin Implant Dent Relat Res 2002;4:110–114.
13. Degidi M, Scarano A, Iezzi G, Piattelli A. Peri-implant bone in immediately loaded titanium implants: An histologic and histomorphometric evaluation in man. A report of 2 cases. Clin Implant Dent Relat Res 2003;5:170–175.
14. Degidi M, Scarano A, Petrone A, Piattelli A. Histological analysis of clinically retrieved immediately loaded titanium implants: A report of 11 cases. Clin Implant Dent Relat Res 2003;5:89–94.
15. Degidi M, Petrone G, Iezzi G, Piattelli A. Histological evaluation of 2 immediately loaded and 1 submerged titanium implants inserted in the posterior mandible and retrieved after 6 months. J Oral Implantol 2003;29:223–229.
16. World Medical Association.Declaration of Helsinki: Ethical principles for medical research involving human subjects. J Postgrad Med 2002;48:206–208.
17. Ohrnell, L.O., Hirsch, J., Ericsson, I. & Brånemark, P.-I. (1988) Single-tooth rehabilitation using osseointegration. A modified surgical and prosthodontic approach. Quintessence International 19: 871–876.
18. Ohrnell, L.-O., Palmquist, J. & Brånemark, P.-I. (1992) Single tooth replacement. In: Worthington, P., Brånemark, P.-I., eds. Advanced osseointegration surgery. Applications in the maxillofacial region, 211–232. Chicago: Quintessence Publishing.
19. Nkenke E, Fenner M. Indications for Immediate Loading of Implants and Implant Success. Clin Oral Imp Res 2006; 17 (Suppl. 2):19–34
20. Jemt, T., Laney, W.R., Harris, D., Henry, P.J., Krogh, P.H.J., Polozzi, G., Zarb, G.A. & Herrmann, I. (1991) Osseointegrated implants for single tooth replacement: A 1-year report from a multicenter prospective study. International Journal of Oral and Maxillofacial Implants 6: 29–36.
21. Yoo RH, Chuang SK, Erakat MS, Weed M, Dodson TB. Changes in crestal bone levels for immediately loaded implants. Int J Oral Maxillofac Implants.2006; 21:253-261
22. Barone A, Covani U, Cornelini R, Gherlone E. Radiographic Bone Density around Immediately loaded oral implants. A case series. Clin Oral Impl Res, 2003;14:610–615.
23. Yoo RH, Chuang SK, Erakat MS, Weed

M, Dodson TB. Changes in crestal bone levels for immediately loaded implants. Int J Oral Maxillofac Implants. 2006; 21:253-261

24. Balshi TJ, Wolfinger GJ, Immediate Loading of Dental Implants in the Edentulous Maxilla: Case Study of a Unique Protocol. Int J Periodontics Restorative Dent 2003; 23:37-45.
25. Szmukler-Moncler S, Piattelli A, Favero GA, Dubruille J-H. Considerations Preliminary to the Application of Early and Immediate Loading Protocols in Dental Implantology. Clin Oral Impl Res 2000: 11: 12–25.

TABLES:

Table I – Health Scale For Dental Implants

Health Scale for Dental Implants*	
Implant Quality Scale Group	Clinical Conditions
I. Success (optimum health)	a) No pain or tenderness upon function b) 0 mobility c) < 2 mm radiographic bone loss from initial surgery d) No exudates history
II. Satisfactory survival	a) No pain on function b) 0 mobility c) 2–4 mm radiographic bone loss d) No exudates history
III. Compromised survival	a) May have sensitivity on function b) No mobility c) Radiographic bone loss >4 mm (less than 1/2 of implant body) d) Probing depth >7 mm e) May have exudates history
IV. Failure (clinical or absolute failure)	Any of following: a) Pain on function b) Mobility c) Radiographic bone loss 1/2 length of implant d) Uncontrolled exudate e) No longer in mouth

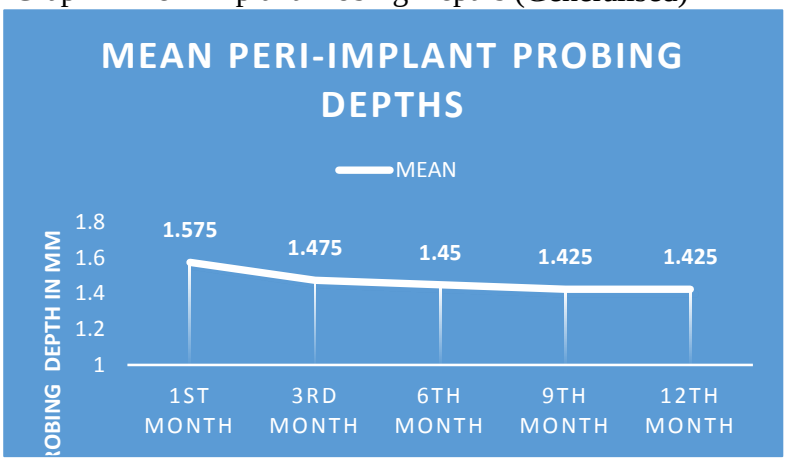
*International Congress of Oral Implantologists, Pisa, Italy, Consensus Conference, 2007.

TABLE II - Clinical Implant Mobility Scale

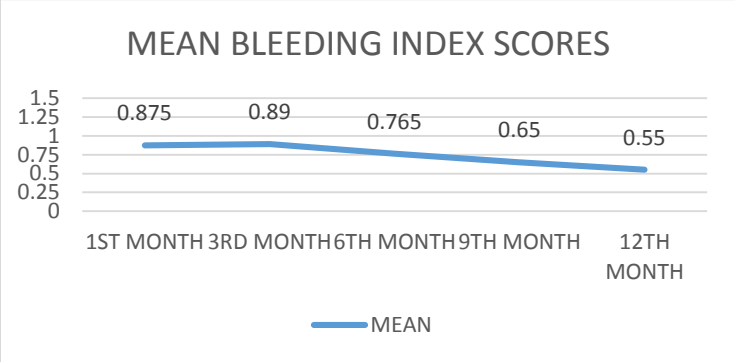
SCORE	INFERENCE
0	Absence of any clinical mobility with 500gms in any direction
1	Slight detectable horizontal movement
2	Moderate visible horizontal mobility
3	Severe horizontal mobility > 0.5mm
4	Visible moderate to severe horizontal movement

GRAPHS:

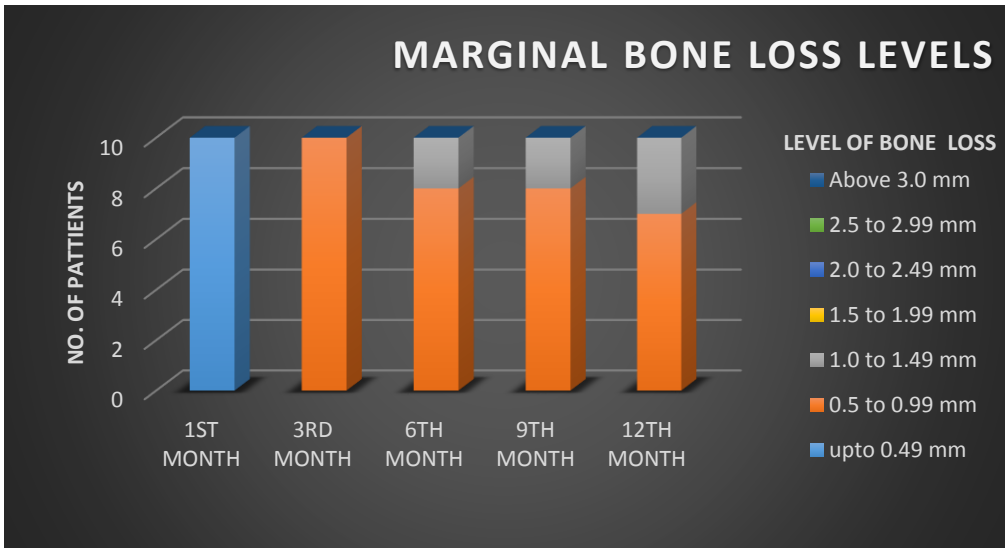
Graph I - Peri-Implant Probing Depths (Generalised)



Graph II - Mean Bleeding Index Scores



Graph III - Marginal Bone Loss Levels



FIGURES:

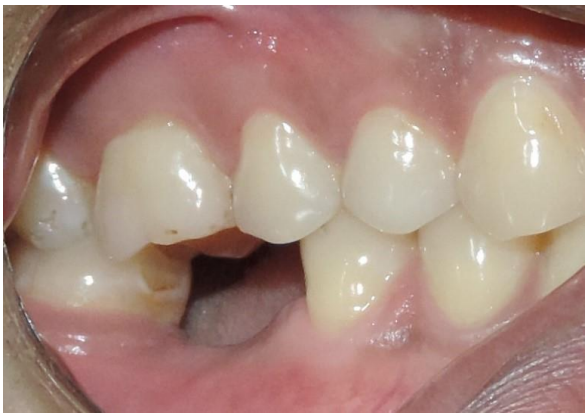


Fig.1 Pre- Operative Photograph

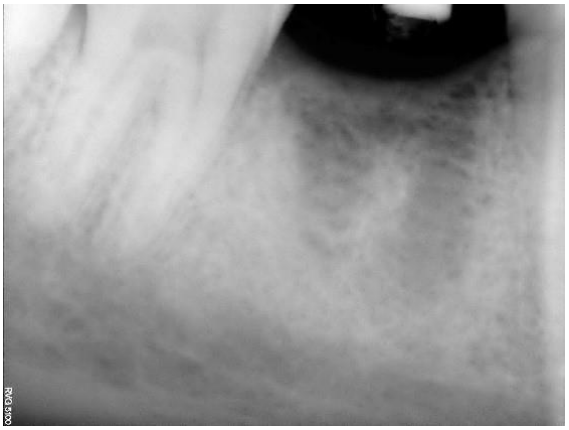


Fig .2 Pre- Operative Radiograph

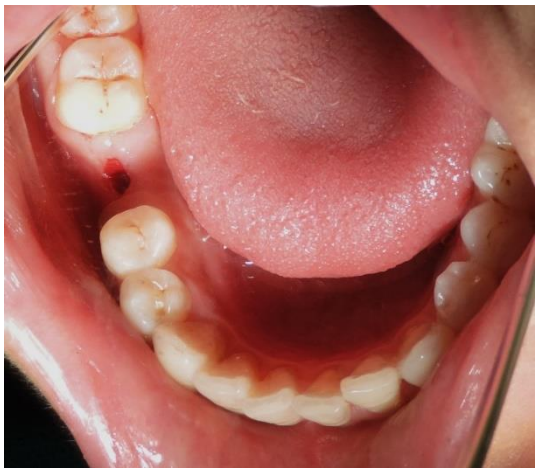
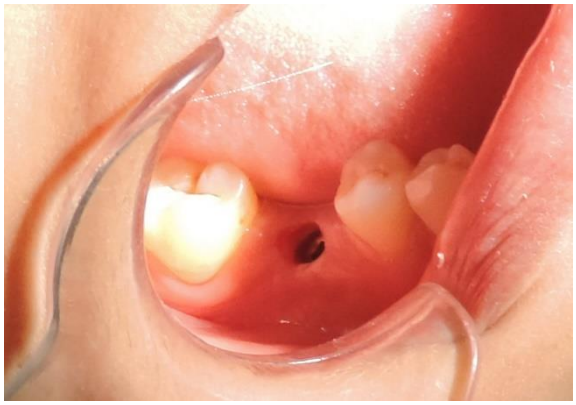


Fig.3 Punch cut incision



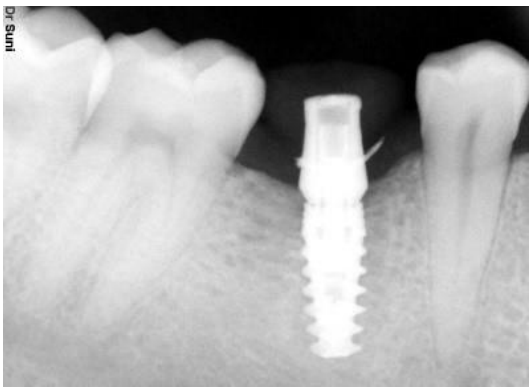


Fig.4 & 5 Implant placed In-Situ & Radiograph

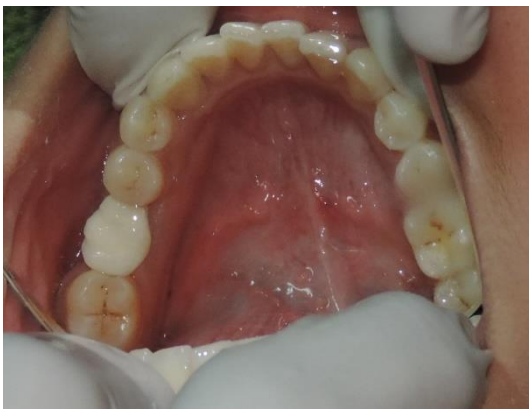
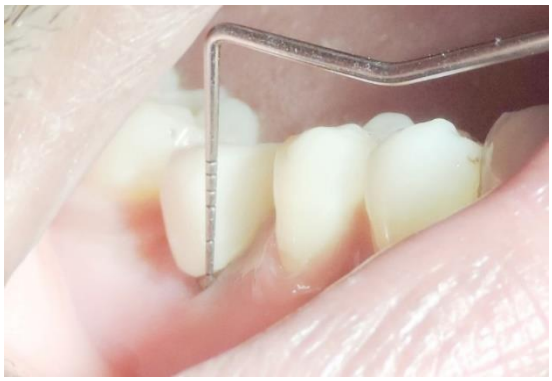


Fig.6 Occlusal View post Temporization



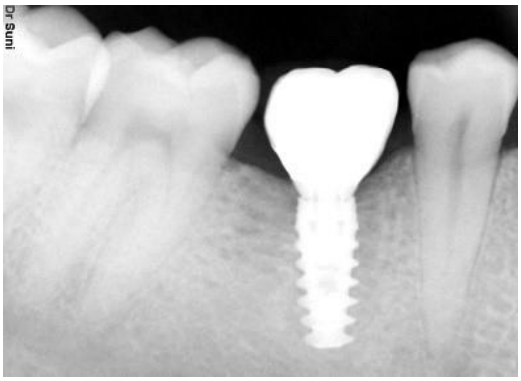


Fig 7&8 Implant with Final Prosthesis