Original Article

COMPARATIVE EVALUATION OF THE CRESTAL BONE LEVEL AROUND DENTAL IMPLANTS PLACED IN ONE STAGE AND TWO STAGE SURGICAL APPROACHES: A CLINICO-RADIOGRAPHIC STUDY

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Abstract

Background: It is general consensus that maintenance of bone around dental implants is one of the most important features in long term success of the implant and over the decades attempts are being made to reduce the amount of crestal bone loss around the implants placed so as to increase the longevity of the dental implants. One such method is the placement of two piece implant in one stage surgery thus, avoiding the need of second surgical procedure and allowing uninterrupted healing of the peri- implant tissue.

Aim: The study plan to evaluate the crestal bone level around dental implants placed through one-stage and two-stage surgical approaches.

Materials and Methods: A prospective randomized, comparative, single blind split mouth study was designed in which twenty 2-piece implants were placed in the posterior mandibular area of ten systemically healthy patients following either two-stage (Group I) or one-stage (Group II) surgical approaches. The crestal bone level was assessed radiographically, at implant placement, at 3 months post implant placement, while implant loading and after 3 and 6 months of implant loading.

Results: The difference in the crestal bone loss around dental implants placed in one- stage and two-stage surgical approaches was statistically insignificant.

Conclusion: One-stage approach for implant placement may be as promising as two- stage surgical approach. Thus, to reduce the treatment period and provide earlier esthetics without undergoing second stage surgical intervention the surgeons can insert implants through one-stage approach.

Keywords: Crestal Bone, Dental Implants, Implant Loading, Osteotomy, Periodontology

Introduction

An adequate dentition is of utmost importance for well-being and quality life of a human being. Tooth loss can be due to various reasons such as caries, trauma and periodontal disease. Over the decades, we have seen the advent of various methods such as removable partial dentures, cast partial dentures, fixed partial dentures, complete dentures to cure edentulism but each method were associated with their particular set of limitations. In order to overcome the problems with conventional prosthesis, implant came into existence and has become one of the most popular and desirable management of tooth loss. Modern dentistry aims to restore teeth to normal contour, function, comfort, thus, maintaining esthetics, speech, and health. This goal can be achieved by measures involving as minimum as removing caries from a tooth and ranging up to procedures undergone to replace several teeth. The ability to meet this goal, regardless of the atrophy, disease, or injury of the stomathognathic system gives implant dentistry its uniqueness. Resulting from the continued research in the field of implant dentistry, improvement in the diagnostic tools, treatment planning and with the advent of various implant designs, materials and techniques, predictable success has now become a reality for the rehabilitation of many challenging clinical situation. By the conventional method the implant is placed in bone after flap elevation at one operation, the recipient site is covered with mucosa, and afterwards a second- stage surgery is carried out when the implant is uncovered again and an abutment or a gingival former is connected to the submerged implant. Hereafter, the impression for the final prosthetic restoration is taken. The achievement of osseointegration after implantation is important in obtaining a successful treatment; however, there are a large number of other factors which play a role in maintenance of crestal bone around the implant such as the surface design of the implant, the loading protocol, the number of surgical procedures undergone, etc. All possible attempts are being made to minimize the detrimental factors such as the improvement of surgical techniques, modifications of the implant design, better quality of implant manufacturing, development of the surgical instruments quality, careful patient screening, adequate treatment of the implant surface and even the surgical approach adapted. In the conventional treatment protocol, there is a need of re-entry in the surgical site to place the abutment, due to which the bone is exposed again and this may lead to further crestal bone loss. To overcome this drawback, one-stage technique evolved in the field. This technique implies that the gingival former will be attached to the implant simultaneously with implant placement, preventing the need for another surgical approach and thus, minimizing the crestal bone loss. Following the one stage approach, the intervention is more acceptable to the patient as only one surgical procedure is involved. Also, the wound healing period that is required for the second surgical intervention is removed thereby shortening the treatment duration and hence, the prosthetic phase can be started earlier by following one stage implant placement approach. Thus, by reducing one surgical procedure we can expect lesser crestal bone level around dental implants compared to the conventional two stage approach.

Based on this, the study was planned to compare crestal bone level around dental implants placed in 1-stage and 2-stage surgical approaches.

Materials and Methods

A prospective randomized, comparative, single blind split mouth study was conducted in the Department of Periodontology, Uttar Pradesh University of Medical Sciences, Saifai, Etawah, U.P. The research protocol was initially submitted to the institutional ethical committee and review board and ethical approval was obtained. Patients visiting the Outpatient Department of Periodontology, with nearly bilateral missing teeth were selected for the study. A total of 20 two-piece Adin implants were fixed in 10 partially edentulous sites (6 males and 4 females of age between 20 to 42 years). The subjects were informed about the benefits and potential risks of the procedure, and a written informed consent was obtained. The selected sites for implant placement were divided into two groups based on the procedure undergone. Each patient selected for the study had two edentulous sites

out of which the group for first site operated was selected by flip coin method. The other site of the same patient falls into the next group. Thus, every subject had group I and II sites both.

- **Group I** (Two-stage approach): Implant placed at stage one surgery and gingival former placed at second surgery.

- **Group II** (One-stage approach): Implant with gingival former placed at stage one surgery.

Two-stage Technique

First stage: After giving mid-crestal incision and using surgical stent as a guide, osteotomy was prepared followed by implant placement equicrestal to alveolar ridge. Cover screw were placed and submerged beneath the mucosal flaps, which were approximated and secured with interrupted sutures. The sutures were removed after 1 week.

Second stage: Three months later, second stage surgery was performed. After giving mid-crestal incision, the cover screw was replaced by the healing abutment (Adin Dental Implant System™) and flaps were adapted by interrupted sutures. Sutures were removed after 1 week and the gingival former was left in place for 3 weeks.

One-stage Technique

After giving mid-crestal incision and preparing adequate osteotomy site, the implants were placed and immediately thereafter healing abutment was attached. The sutures were adapted around the site using interrupted sutures and the gingival former were left exposed to the oral cavity during healing. The sutures were removed after 1 week. Patient was advised for cold fermentation for first 24 hours. Post-operative medications included a NSAID agent Diclofenac-paracetamol combination twice daily for post-operative discomfort and amoxicillin 500 mg thrice a day for 5 days and thorough rinsing of mouth with 10ml of 0.2% chlorhexidine gluconate from the next day after surgery for 3 weeks for plaque control. The restorative treatment was initiated 3 months after placement of implant in both the groups. The prosthetic abutments (Adin Dental Implant System™) replaced the healing abutments and the subjects were rehabilitated with screw-retained porcelain fused to metal prosthesis. The crestal bone loss was assessed at baseline, 3 months after implant placement, at implant loading, 3 and 6 months following implant loading. The measurements were assessed mesial and distal to the implant by having the platform of the implant as the reference point. The evaluation of the crestal bone loss was done by using imaging software ADOBE PHOTOSHOP 7.0. The implant abutment junction and alveolar crest were located on image. Using software, lines were drawn from implant abutment junction to alveolar crest. The distance between the two points was displayed on screen from which the crestal bone loss was measured. To evaluate the alterations in the crestal bone level, the bone level was considered as 0 at baseline (treatment flowchart is attached).

Data Analysis

Data was summarized as mean±SD. Data were entered into Microsoft Excel spreadsheet and checked for any discrepancies. The data was analyzed with Statistical Package for Social Sciences (SPSS) for Windows, version 24.0 (IBM Corp., Armonk, N.Y., USA). Confidence intervals were set at 95% and values of $p <$

0.05 were interpreted as statistically significant. Continuous variables of the two groups over the periods were compared by measures of ANOVA. Groups were compared by paired t-test.

Results

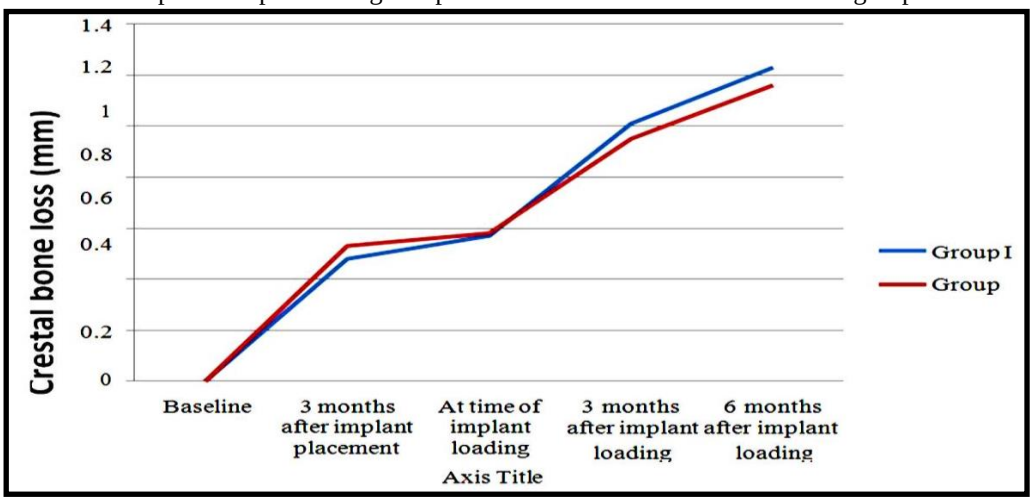
There were a total of 20 sites in 10 patients divided into two groups (Group I = 10sites and Group II = 10sites). Out of the selected subjects, there were 6 males (60%) and 4 females (40%). The mean age of Group I and Group II was 29.3±7.54 years.

Group I - The mean crestal bone level was 0.48+0.11mm at 3 months after implant placement from the level of platform of the implant. It increased to 0.57±0.11mm at the time of implant loading, showing an increase of 0.09mm. At 3 months following loading of implant, the value for crestal bone loss obtained was 1.01±0.95mm showing an increase of 0.44 and further increased to 1.23±0.07mm at 6 months of implant loading with an increase of 0.22mm. The results obtained were statistically significant. (p = 0.00)

Table 1: Inclusion and exclusion criteria

INCLUSION CRITERIA	**EXCLUSION CRITERIA**
Age group- 18 to 60 years	Medically compromised patients
Two or more missing teeth	Pregnant and nursing females
Sufficient alveolar bone at the site	Smokers
Systemically healthy patients	Patients with parafunctional habits
Periodontally healthy patients with proper oral hygiene	Poor bone quality or voulme
Adequate patient compliance	History of consumption of drugs affecting bone metabolism

Graph 1: Graph showing comparison of crestal bone loss in both the group



Group II - The mean crestal bone level was 0.53±0.12mm at 3 months after implant placement from the level of platform of the implant. It increased to 0.58±0.12mm at the time of implant loading, showing an increase of 0.05mm. At 3 months following implant loading the value obtained was 0.95±0.11mm showing an increase of 0.37mm and further increased to 1.16±0.13mm at 6 months of implant loading with an increase of 0.21 mm. The results obtained were statistically significant. (p = 0.00) Comparison between crestal bone level scores of Group I and Group II at baseline, 3 months post implant placement, at implant loading, 3 and 6 months following implant loading showed no statistical significant difference with p=1.00, p= 0.34, p=0.84, p=0.21 and 0.15 respectively (graph 1 & table 1).

Discussion

Maintaining adequate crestal bone levels around dental implants are critical for the successful outcomes. Crestal bone loss not only affects the esthetics due to subsequent loss of interdental papilla but can also put at risk implant survival in the long term.[1] According to the consensus report from the 1st European Workshop on Periodontology, during the first year after the insertion of the prosthesis, the average crestal bone loss should be less than 1.5 mm and subsequently less than 0.2 mm annual bone loss afterwards for the implant to be called successful.[2] Hence, it is crucial to maintain the marginal bone level around the dental implant for the long-standing success of any implant treatment. For predictable osseointegration to occur, a well orchestrated sequence of bone healing occurs at the surface of dental implants. During healing, osteoblasts derived from fibroblast-like osteogenic progenitor cells, deposit woven bone which gradually grows and progresses towards the implant surface. During the first three months of healing, this woven bone is replaced by lamellar bone with increasing bone to implant contact and requires an undisturbed site. During this period, marginal bone loss occurs around the dental implants. The amount of crestal bone loss around dental implants depends on multiple factors and all possible attempts must be done to reduce the bone loss for the longevity of the implants. Originally, a two-stage surgical approach was encouraged to avoid preloading and to minimize the bone resorption around dental implants during the early phase of healing.[3] This approach required a 2-piece implant system consisting of a implant and a healing abutment. The implant is submerged during the first surgical procedure, and a healing abutment is connected to the implant during the second stage surgical procedure.[4] However, while using a 2 piece dental implant, a micro-gap persists between the implant platform and the abutment which may lead to microbial contamination resulting in persistent inflammation and may result in marginal bone loss. For this concern, one-piece implants and one-stage surgical techniques were developed but, studies have confirmed that even the presence of micro-gap does not seem to have a detrimental effect on the amount of marginal bone loss around dental implants.[5] Gender, age of patient, implant-abutment location in relation to the crestal bone level, implant site and the dimensions of implant placed are some of the features beside the surgical protocol followed that may affect the bone level around implants and hence, play a vital role in deciding the long-term prognosis of dental implants.[6] The current study, involved bilateral placement of implant in each patient with both the sites being in different groups, thus, the bias due to gender, age and implant site (posterior mandibular region) were removed. Also, as all the implants were placed equicrestal, and had similar implant surface and geometry, the bias that could have been incorporated due to these factors was also eliminated. Szmukler-Moncler et al.,[7] suggested that for uninterrupted remodeling of bone around the implant surface, a 3-month healing period is essentially required following implant insertion. Therefore, following a delayed loading protocol, all the implants were loaded 3 months after their placement in the site. In both the groups, until 3 months following implant placement, crestal bone level changes in terms of mean bone loss around the implants were observed. The bone loss was also evident after implant loading when measured up to 6 months after implant loading. This is in agreement with the study done by Enkling et al.[8] who suggested that significant alterations in the crestal bone level occurs during the initial healing period after implant placement. Similarly, Cochran et al.,[9] demonstrated that during the first 6 months following implant insertion significant bone remodeling occurs in the crestal bone around dental implants. The authors suggested that during this period, there are multiple factors that impact bone remodeling and are responsible for crestal bone alterations as the osteoclastic activity outweighs osteoblastic activity. The osteotomy preparation for the implant placement disrupts the vascular supply. Likewise, the second surgical procedure, removal of the cover screw or gingival former further hampers the peri-implant tissue healing and these factors collectively lead to let crestal bone loss. A higher crestal bone loss was seen in Group II in comparison to Group I (0.53±0.12mm and 0.48±0.11mm respectively) when intergroup comparison was done at 3 months after implant insertion. This is in agreement with studies done by Enkling et al.[8] and various other researchers. They suggested that during the initial period of healing following implant placement, greater bone loss was encountered around implants placed via one surgical approach in comparison to the two stage implant placement approach. The first 3 months after implant placement is a crucial time for osseointegration and the undisturbed healing around dental implant due to the lack of communication between implant and oral cavity may be responsible for the lesser bone loss around submerged implants. Fiorellini et al.[10], Choi et al.[11] and Gulati M. et al.[12] also reported that implants placed following two stage surgical approach have better anchorage in the initial phase following implant placement when compared to implant placed using one stage surgical approach. Thus, suggesting better osseointegration in the submerged implants due to undisturbed healing. All subjects demonstrated higher crestal bone loss in Group I sites in comparison to Group

II sites after 3 months of implant loading (1.01±0.95mm and 0.95±0.11mm respectively). Thus, the mean crestal bone loss was more in Group I. Further, even up to 6 months post implant loading the crestal bone loss increased in both the groups with more bone loss in Group I than in Group II (1.23±0.07mm and 1.16±0.13mm respectively).This is in agreement with the results demonstrated by Fiorellini et al.[10] who demonstrated that following abutment attachment, the bone resorption trends reversed and non-submerged implants exhibited less bone resorption when compared with submerged implants. They also suggested that second surgical intervention for the attachment of transmucosal abutment, disturbs the healing of the submerged implants by their exposure to the oral cavity and the trauma induced due to second stage surgery could have resulted in more crestal bone loss around submerged implants as compared to non-submerged implants. These results were also seen in the present study between 3 to 6 month interval after implant loading. Enkling et al.[8] also mentioned this difference in temporal pattern of bone level alteration in 2011. However, at the final evaluation, the difference in the mean crestal bone loss between both the two groups was statistically insignificantly (Group I = 1.23±0.07mm and Group II= 1.16±0.13mm; $p = 0.15$), which is in aggrement with Heydenrijk et al.,[13] Batenburg et al.,[14] and Gheisari R. et al.[15] and several other researchers who have also demonstrated statistically insignificant difference in crestal bone loss between submerged and non- submerged implants. Chaushu L. et al.[16] in a 18 year retrospective study have found that lack of long- term differences in implant survival, marginal bone loss and gingival health around implants after one- or two-stage implant placement procedures promoted a significant change in the period of 18 years, increasing the prevalence of one stage-surgery as an evidence-based preferential protocol when there are no specific contraindications thus, making the one stage surgery more preferable for both the operator and the patients. However, Park et al.[17] demonstrated a statistically significant difference in the amount of crestal bone loss between implants placed following single stage and two-stage technique, with higher bone loss around two stage implants. This contrasting result could be explained by the lack of standardization of the variables that were responsible for influencing bone resorption and inclusion of systemically unhealthy patients in their study.

Conclusion

The findings of this study demonstrated that difference in crestal bone loss around dental implants placed in one-stage and two-stage surgical approaches was statistically insignificant. The conventional two-stage procedure when undergone cause increased treatment time, increased cost of treatment, second surgical procedure hence leading to reduced compliance of the patient. The present study shows that one stage procedure is equally promising as the conventional two stage procedure. Thus, to reduce the treatment time and provide earlier esthetics without undergoing second stage surgical intervention the surgeons can insert implants through one-stage approach. However, to establish the findings of the present study, further long-term studies with larger sample size are necessary.

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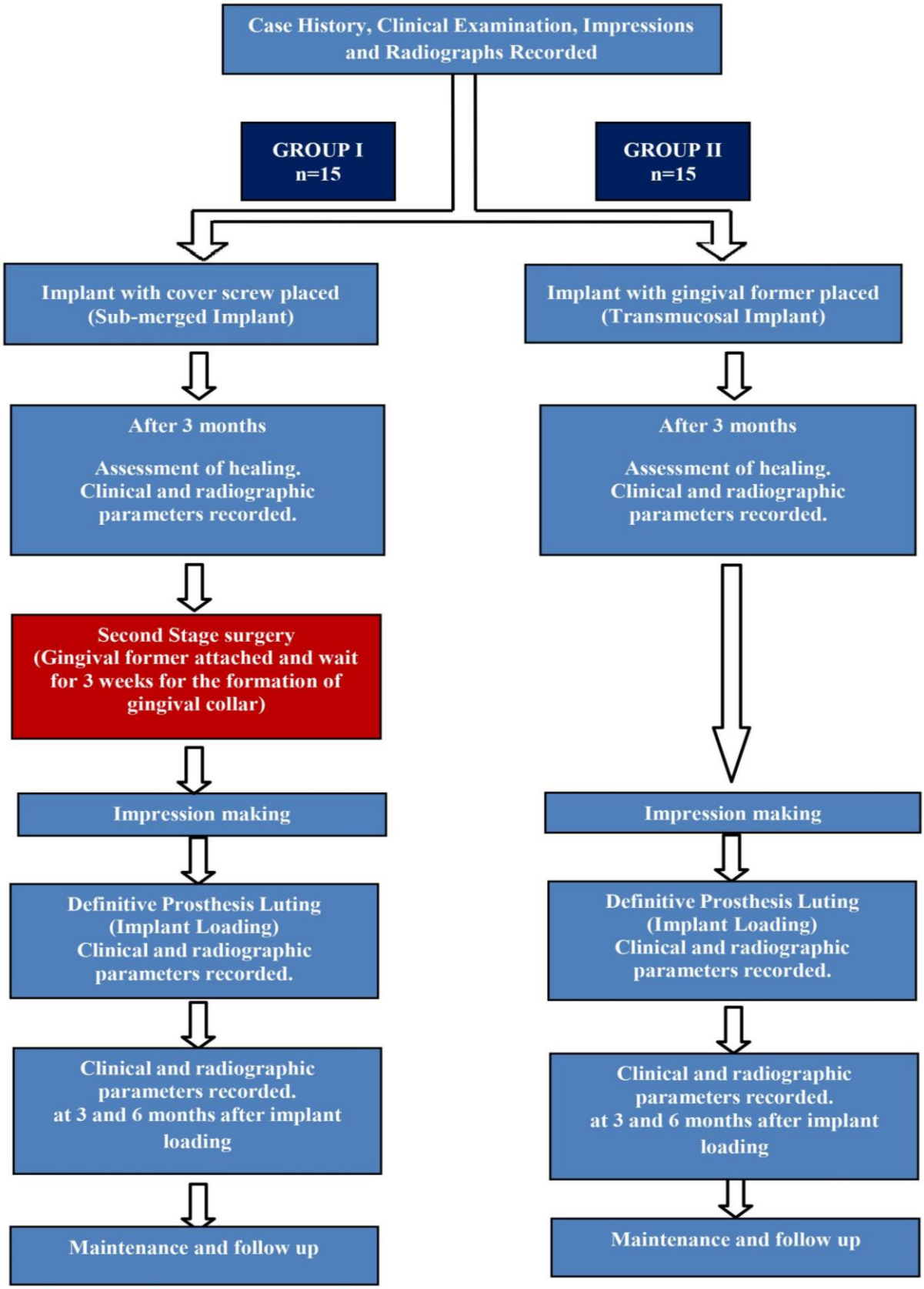
Case History, Clinical Examination, Impressions and Radiographs Recorded
GROUP I n=15
GROUP II n=15
Implant with cover screw placed (Sub-merged Implant)
Implant with gingival former placed (Transmucosal Implant)
After 3 months
Assessment of healing. Clinical and radiographic parameters recorded.
After 3 months
Assessment of healing. Clinical and radiographic parameters recorded.
Second Stage surgery (Gingival former attached and wait for 3 weeks for the formation of gingival collar)
Impression making
Impression making
Definitive Prosthesis Luting (Implant Loading) Clinical and radiographic parameters recorded.
Definitive Prosthesis Luting (Implant Loading) Clinical and radiographic parameters recorded.
Clinical and radiographic parameters recorded. at 3 and 6 months after implant loading
Clinical and radiographic parameters recorded. at 3 and 6 months after implant loading
Maintenance and follow up
Maintenance and follow up