CLINICAL PERFORMANCE AND RADIOGRAPHIC EVALUATION OF IMMEDIATE RESTORATION OF SINGLE TOOTH EDENTULOUS SITES WITH BASAL OSSEOINTEGRATED IMPLANTS – A PROSPECTIVE STUDY

Dissertation Submitted to

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

In partial fulfillment for the Degree of

MASTER OF DENTAL SURGERY

BRANCH III

ORAL MAXILLOFACIAL SURGERY

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CERTIFICATE

This is to certify that this dissertation titled **"CLINICAL PERFORMANCE AND RADIOGRAPHIC EVALUATION OF IMMEDIATE RESTORATION OF SINGLE TOOTH EDENTULOUS SITES WITH BASAL OSSEOINTEGRATED IMPLANTS - A PROSPECTIVE STUDY"** is a bonafide record of work done by **Dr. SUNIL SHROFF** under our guidance and to our satisfaction during his postgraduate study period between 2009–2012.

This dissertation is submitted to **THE TAMILNADU Dr. M.G.R.MEDICAL UNIVERSITY**, in partial fulfillment for the award of the Degree of **MASTER OF DENTAL SURGERY – ORAL AND MAXILLOFACIAL SURGERY, BRANCH III**. It has not been submitted (partial or full) for the award of any other degree or diploma.

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CONTENTS

In recent years, patient demands for immediate restoration and desires to eliminate the compromised esthetics, function, discomfort and inconvenience associated with traditional two-stage implant procedures. These have fostered interests in early and immediate loading. Literature on immediate loading of a single tooth restoration tend to be short term with occlusal contact that ranges from unspecified, or non-occluding to lightly or fully occluding.

Treatment plans which include several steps of surgery are less attractive or simply rejected because the costs of lost work-time and travelling add up to the total costs of treatment. In addition the willingness to wait for the healing of the bone and to suffer a multi-step treatment plan and especially to accept collateral damages in bone donor regions is rapidly vanishing. This all advocates for the use of basal implants as one of the options to avoid augmentations, bone transplants, distractions and similar additional operations.

Placement of root form implants in the atrophic regions of the jaw especially in posterior mandible and below the maxillary sinus can be difficult and often impossible. Adjunctive procedures for enlarging the bone volume increase the risks of overall treatment and they reduce thereby the predictability.

Patient who typically may be turned down due to smoking or periodontal involvement are good candidates for basal implants[16].

Basal implants provide transmission of masticatory forces not to the cancellous bone as conventional cylindrical or screw form implants, but to the stable cortical bone.

These implants are placed bicortically and transosseously and atleast one base-plate is anchored in the basal cortical bone. The primary amount of crestal and spongeous

bone is unimportant for this implant pattern to become fixed. They utilize basal bone areas free of infection and resorption, which are not necessarily located near the masticatory surfaces, therefore are also well suited for placement immediately after extractions [14]. This rationale stems from orthopaedic surgery and from experience that cortical areas are needed in the structure, therefore are resistant against resorption and reconstitute itself easily. At the same time load bearing capacities of cortical bone are many times higher than those of spongious bone[20]. They have a functional applicability in bone tissue with a low quality where other types of implants fail [11].

It is understood today, that basal implants undergo a dual mechanism of integration: ring areas in direct contact with the native bone show primary integration, though osteonal remodeling also occurs. Empty slot areas (the void space left after osteotomy and insertion) fills with woven bone first and undergoes a remodeling later on[27]. This dual integration also allows placement of basal implants right into extraction sockets of teeth, cavities and empty spaces left after cystectomies or granulation tissue removals, or even be applicated trans-sinusally[27]. Basal implants have long being used in ridges with quantitative and/or qualitative poor bone and avoid augmentations and reopening with immediate function.

In crestal implantology, sterile insertion is a major requirement, since no gap is left for suppuration. Pre-existing residual osteitis within the bone or micro-organisms introduced during the insertion can bring treatment with crestal implants to an end very quickly. BOI implants by contrast are highly resistant to infection[27].

The BOI's procedure is not only the fastest and safest treatment procedure today in dental implantology, it is also the cheapest.

There is a long tradition of combining basal implants with the same or other implant systems or with stable teeth. Available data on use of these implants for single tooth replacement is minimal. Professionals who use basal implants continue to discuss whether to do so or not, which should be validated with such data analysis as reported in this study.

To prospectively evaluate the clinical efficiency and radiographic assessment of **Basal Osseointegrated (BOI) implants** in single edentulous sites with immediate restoration and early occlusal loading.

The first enossal implant design that relied on a lateral insertion path and capitalized on the stability of inner and outer cortical bone was devised in Italy (FP Spahn, Personal Communication)[27]. The disk and vertical threaded pin were inserted separately in this design, the latter through an extra vertical drill hole. Finally both components were connected with a screw. The technological means of single unit titanium implants of adequate size were not available at that time.

The first single unit implant was developed and used by Jean-Marc Julliet (1972)[27]. This design was available in one size and offered no basal plate resilience. The scope of indications for this design was limited to the areas where the basal plate reached both cortical structures, so that its use was essentially confined to the anterior segments of either jaw.

The original implant design by Lobello was based on inserting two separate components, whereas the design by Julliet featured a welded joint between the threaded pin and basal plate[27].

In 1991, Scortecci et al. published a retrospective study on the clinical outcomes of his Diskimplant system. In the years 1979-1989, a total of 5,848 implants had been inserted, 590 of which had to be removed because the disc diameters were too small or the threaded pins were too short. Also another factor was that the original discs were not perforated at all[27].

With Scortecci's development of standardized cutters for implant beds, lateral implantology ultimately became an option even in the hands of less skillful surgeons. Therefore Scortecci is rightly regarded as one of the ***"Founding Father's of Lateral implantology"*** [27].

Ihde and Spahn laid the foundation for basal osseointegration, by applying for a patent on the first elastic implant design, thus turning away in theory and practice from the rather mechanistic theory of crestal implants and rigid bone-implant prosthetic systems[27].

The basal implants were configured to match the anatomical shape of the jaw bone and the crestal plate was placed in a more resilient position than the basal plate. By virtually eliminating the risk of crestal osteolysis in maxilla, this development can be regarded as a milestone in the history of BOI[27]. At the same time, load transmission in the area of the crestal plate was confined to the palatal bone, which apparently was much better suited for this task in terms of structure, resorption tendency and blood supply than the vestibular bone.

Ihde and Spahn in a collaborative effort developed implants that behaved elastically inside the bone, allowing resilience of the threaded pin[27]. This enabled the transmission of unequal parts of load on the base plate. The base plate was designed to be more rigid than the crestal plate. Hence, the larger amount of chewing forces was transmitted to the lower plate while the crestal plate provided stabilization.

Asymmetrical BOI implant design, first described in 2000, was capable of compensating for the centrifugal resorption of the mandible, while the bone cavities for insertion could still be prepared with rotationally symmetrical instruments[27]. This design allows coping with the centripetal resorption of the upper jaw and as well as with centrifugal resorption of the lower jaw.

The idea of basal, wide-area support for implants was taken up by many developers at the same point. The resolution of situations in which insufficient bone volume was available was what gave rise to various ideas. Only Julliet (1972), Scortecci (1985) and Ihde (from 1998) ever turned their ideas into successfully marketable and clinically practical products[27].

Ihde and Mutter performed a retrospective case series of 275 BOI implants in 228 patients over a period of five years. Molars were replaced with BOI implants in combination with natural abutments. Osseointegration was achieved in 254 implants at follow-up. Fifteen implants were lost. This study shows that basal implants work well in combination with natural abutments.

Donsimoni et al performed a retrospective case series evaluating 1352 consequitive basal implants placed over a 10 year period in 234 circular bridges. Osseointegration was achieved in 97% of cases.

Gerard Scortecci (1999)[16], conducted a clinical trial over a 41 month period where 783 titanium implants (627 laterally inserted disk implants, with or without 156 axially inserted implants) were placed in 72 consequtive patients

with completely edentulous maxillae using an immediate loading protocol. He concluded that immediate loading of laterally inserted disk-design implants with a fixed, functional prosthesis is a safe and reliable method for management of completely edentulous maxillae. The initial bucco-palatal cortical anchorage achieved with these implants ensures sufficient stability for osseointegration, and lateral insertion technique makes them suitable for seating in atrophic maxillae.

Sigmar Kopp (2007)[16], presented a report on the outcomes of using a basal implant design for treating patients especially with poor quality and quantity of bone under immediate load conditions. Out of the 302 implants placed in 88 patients, 13 implants failed during follow-up period giving an overall survival rate of nearly 96%. Basal implants used for single tooth replacement showed the lowest survival rate (90.9%), but this was the result of specific overload. The highest loss rate was found in the first days and the survival rate was found to increase by time in situ to 100% for 3 years and more.

Sigmar Kopp (2007)[17], showed an example of a patient with congenital hypodontia who provide thin bone ridges due to the absence of adequate growth stimuli. The transosseous installation of basal implants and their cortical anchorage leads to fast rehabilitation and high aesthetic results.

Henri Diederich (2007)[6], adopted a two-stage prosthetic protocol to be appropriate if teeth are extracted in anterior maxilla. Due to prior extraction of several residual teeth, pronounced bone remodeling and soft tissue

recontouring is expected. This necessitates readaptation of the tissue side of the bridge after 4 months.

Sigmar Kopp (2007)[18], found that basal implants can be used immediately after extraction, even in massive periodontal involved cases. By use of BOI, just one session is needed for teeth extraction, implant placement, and immedete loadable bridge insertion. A functionally balanced occlusion can be achieved on by installation of circular bridges on 4 implants. The thin vertical shaft is smooth and has no direct load transmitting function to the bone, giving no retention to plaque or calculus. So BOI is periodontal preventive designed and practically proved.

Sigmar Kopp (2007)[23], showed by his study that, basal implants themselves are safe and effective when used without combination with crestal implants.

Henri Diederich (2008)[5] , discussed an approach of implant treatment in a patient with pronounced atrophy and concluded that immediate loading with a fixed restoration could be offered and successfully implemented with the help of BOI implants and tuberopterygoid screws despite an inadequate bone volume in the vertical and horizontal planes.

Ihde et al. (2008)[13] , developed a model that accurately represented the interface between bone and basal implants throughout the healing process and applied it to the biological scenario of changing load distribution in a basal implant system over time through finite element analysis, using multiple

models with changing bone-implant contact definitions. They showed that, in upgraded models which more closely approximate the biological scenario with basal dental implant, peak von Mises stresses decreased at the implant interface; however they increased at the bone interface as a harder contact definition was modeled. Further, a shift in peak stress location was found within the implants during different contact definitions (i.e., different stages of bone healing). In case of hard contact, the peak stress occurs above the contact surface, whereas in soft contact, the stress peak occurs in the upper part of the contact area between the bone and the vertical shaft of the implant. Only in extreme soft contact definitions, were the peak stresses found to be near the base of the implant.

Stefan Ihde (2008)[22], in his case report showed that basal implants are an excellent alternative in patients with implant failures, to provide a new implant(s), in lieu of prosthesis and allow the patient to return to normal masticatory function with little or no delay.

Sigmar Kopp and Wilfried Kopp (2008)[22,25], described the immediate placement of basal implants even in infected extraction sockets under real immediate prosthetic loading conditions as a safe and effective way of treatment. He concluded that waiting for healing of the sockets after extractions does not improve the general success rate of BOI and BCS (basal compression screw) implants and may be generally avoided.

Stefan Ihde (2009)[19], discussed the value of using basal implants and the differences that exist between basal implants and crestal implants in peri-operative status, infection around integrated implants, load transmission and replacement of failing implants. He concluded that, the technique of basal implantology solves all the problems connected with conventional (crestal) implantology.

Konstantinovic et al. (2010)[28], reported a case of a patient who underwent facial reconstructuion with nasal epithesis anchored on basal (disk) implants after ablation of midface squamous cell carcinoma. After an unloaded osseointegration phase of three months, all implants appeared well integrated according to radiological criteria and clinical stability. The case was followed up for 18 months and there were no signs of recurrence of the tumor , nor any complications related to the implants. The authors concluded that disk implants that were applied in this case present an excellent alternative, particularly in cases with minimal available bone, resulting in reduced complications in elderly oncological patients.

Borak L et al.(2010)[10], in the first of their biomechanical study of single and double disk implants, described the mechanical interaction between the implant and the bone tissue in terms of the quality of bone tissue, the osseointegration level, and the character of the implant anchorage. They analysed the cranioapical displacement of the implant and the strain intensity

in cancellous bone. They described three variants of anchorage within the bone :

Variant A - mechanical interaction between implant disk, inner and outer cortical bone.

Variant B - interaction with outer cortical bone only.

Variant C – implant disk is smaller than space between outer and inner cortical bone where there is interaction with cancellous bone only.

They concluded that only Variant A and the double disk implant guarantees the possibility of immediate loading of the implant after the application regardless of the quality of bone tissue. Also despite a negligible difference in displacements in variants A and B, the difference in strain intensity is significant.

Marcian P et al. (2010)[11], in second part of the same study, focussed on the stress-strain analysis (and toleralability) of disk implants as loaded during the masticatory process.

Adel.A. Chidac (2010)[1], described the various surgical techniques to avoid a sinus lift procedure and showed that disk implants are a favourable alternative to sinus elevation and bone augmentation other than tilted implants and tuberosity implants.

Scortecci et al. (2010)[4], described a case of squamous cell carcinoma of the oral cavity managed with ablative surgery, mandibular reconstruction with a fibula free flap, and implant placement during the same session. They concluded that early functional dental rehabilitation with one step immediate loading procedure is possible provided the concepts of basal implantology are respected.

Stefan Ihde and Sigmar Kopp (2010)[20], reviewed the available literature on basal implants and lined out a treatment concept without bone augmentation for upper jaw. They have presented simple treatment plans to avoid sinus lifts using basal implants, as almost all patients have sufficient horizontal bone naturally, even if vertical bone is missing.

Ihde et al. (2010)[21], showed that palatal and vestibular placements of basal implants may be combined to increase the primary stability of the bridge, splinting the implants under immediate load conditions.

Ihde and Konstantinovic (2011)[14], explained the four options for treating extremely atrophic posterior mandible with basal implants:

a) Infra-nerve implant placement.
b) Placement of basal implants after caudalisation of alveolar nerve and vessels.
c) Placement of basal implants in anterior part of ascending ramus of mandible.

d) Application of basal implants as sub-periosteal implant.

They concluded that these methods are a superior alternative to the traditional techniques of increasing the bone volume, such as distraction-osteogenesis and vascularized or non-vascularized bone block transplants.

E. Ruzov et al. (2011)[12], showed that puncturing the flaps and flipping them over the implant's head provides the possibility for closing tightly over single-piece (lateral) basal implants. In combination with double-mattress sutures this technique allows to create a tight seal around the projection vertical part of the basal implant.

Siddharth Shah (2011)[15] , showed that in severely resorbed cases of distal mandible, the implant must be placed well below the amber line (linea obliqua) for stable results. In this way the implants rest in the resorption stable bone and the success rates are high.

T. Goldman et al. (2011)[3], analysed the force transfer and stress distribution of an implant supported circular bridge with rectangular crossection bridge in the atrophied mandible and considered two different designs for the bridge in posterior mandible – a) direct straight line connection between the posterior implant in the mandible and the bridge and; b) connection between posterior implant and bridge with posterior implant designed as technical abutments. They concluded that direct straight line connection is from the biomechanic point of view, the least desirtable solution for the BAST type implant, because

stresses within the implant, the bridge and the bone are higher compared to prosthetic solutions where implant remains outside the lower arch.

S. Ihde et al. (2011)[7], showed the relationship between bridge core diameters, the resistance of peri-implant bone and stresses around the endosseous base plates of immediately loaded basal implants using finite element analysis and concluded that the success of a treatment with immediately loaded basal implants in strategic positioning depends strongly on the rigidity of the bridge, i.e. on the bridge-core diameter. Dimensions of 2.5x3.5 mm or more for the bridge core are required for treatment in immediate load protocols.

Selection of Patients

In this clinical study, 11 patients presenting with one missing tooth satisfying the inclusion and exclusion criteria, reporting to the Department of Oral and Maxillofacial Surgery, Ragas Dental College and Hospital, Chennai from 2010-2011 were selected. Informed consent was taken prior to surgery and the source data was collected in a proforma.

Diagnostic Protocol

A comprehensive diagnostic assessment was performed. Clinically, alginate impressions were taken to fabricate the diagnostic casts and these were articulated. Bone mapping of the edentulous site was performed under local anesthesia and the measurements were transferred to sagittally sectioned plaster models to estimate the bone width and form.

Radiographically, an OPG was taken after insertion of a template containing a metallic ball of a fixed diameter to eliminate the magnification error and estimate the available bone height at the edentulous site. Also, an IOPA radiograph of the edentulous site by using a standardised paralleling cone technique with a film holder and an aiming device was taken.

Surgical Protocol

This implant was placed in the edentulous locations under local anaesthesia (2% lignocaine with 1:80,000 adrenaline), by local infiltration. After raising a full

thickness flap, the implant bed was created through lateral access using vertical cutters, horizontal cutters and combination cutters. These cutters were used with an high speed aerotor handpiece for the vertical cut and a reduction gear contra-angle handpiece at a speed of 3000 rpm with copious irrigation for the lateral horizontal cuts. The first vertical bone cut was performed with tungsten carbide surgical bur followed by the vertical cutter to avoid unneccesary wear of the vertical cutter. Next, the combination cutter was used to create the initial lateral cut and refine the vertical cut creating a path of insertion for the implant. This was followed by the lateral cutter which enlarged the lateral cut according to the implant size and type used. For double or triple disk BOI implant, an additional double-disk cutter was used to maintain the distance between the crestal and the basal disk. Subsequently the basal cut was widened according to the diameter of the basal disk. In case of triple disc BOI implant, the double disk cutter was used twice, with the cuts overlapping each other to create the third slot. The implant size and type (depending on number of disks as single disk, double disk and triple disk) were selected depending on the amount of bone available. More than one disk was preferred in cases with sufficient bone as it would provide better cortical anchorage and stability of the implant. Once the vertical and lateral bone cuts were created, the implant was inserted through a lateral access using carefully dosed hammer style strokes with a pencil osteotome and mallet. The rectangular side of the basal disk faces the vestibular aspect and the rounded side remained on the medial aspect. The presence of sufficient support was verified visually and manually by testing with fingers. Any part of the projecting disk was then bent and adapted to the bone surface. In cases where there was a bony defect left behind, the implant surface was covered on its buccal/labial side with particulate alloplastic graft followed by placement of a resorbable membrane. However this was

done for esthetic areas only like the maxillary anterior region as primary stability was not a problem with these implants. Sterile Ringer's lactate was used as a cooling medium as it is said to be more benign than saline. Horizontal mattress sutures were placed for closure using 3-0 silk or 4-0 vicryl suture material in case of esthetic areas where simultaneous bone grafting was done.

Post-surgical Protocol

All patients were administered with a single dose of steroid (Inj.Decdan 8mg) and analgesic (Inj.Voveran 75mg) intramuscularly, immediately after the procedure. They were also prescribed a regime of oral antibiotics (Cap.Amoxicillin 500mg, TDS; Tab. Metrogyl 400mg TDS), analgesics (Tab.Imol, BD) and H2 receptor antagonist (Tab. Rantac 150 mg, BD) for a period of 5 days. They were advised to perform ice - pack application extraorally over the surgical site for a period of 48 hours in an intermittent fashion. Then onwards, they were encouraged to perform warm saline mouth rinses daily. Suture removal was done for all patients on the 5^{th} post - operative day.

Restorative Protocol

Impressions were made for provisional restoration immediately after insertion of the implant within 2-3 hours duration and the implants were provisionalised with a non - occluding prosthesis on the same day for most of the cases, with self cure crown and bridge acrylic material. Only, two patients were delivered the prosthesis the next day. The provisional crowns were cemented to the abutments with a temporary

cement (EBA modified Zinc oxide Eugenol cement material) . Three months later, the implants was definitively restored with fully occluding ceramometal restoration after thorough clinical and radiographic evaluation as mentioned in the follow-up protocol below.

All patients were instructed to avoid any occlusal loading over the implant immediately after placement and for a period of 3 months, after which they were asked to subject the implant to moderate loading forces only, initially. A gradual increase in loading was advised, till the osseointegration period was complete (approximately one year).

Follow-up Protocol

Clinical and radiographic data was collected at 1day, 1week, 3weeks, 1month, 3months, 6months and 12months follow-up appointments and the data collected was tabulated. Clinical evaluation was done by: manual pressure and percussion of the implant, status of peri-implant gingiva, status of adjacent and opposing teeth, oral hygiene.

Standardised radiographic assessments was done by: IOPA radiograph of the implant site using the standardised paralleling cone technique with a film holder and an aiming device, to rule out presence of implant mobility or peri-implant radiolucency. Peri-implant marginal bone levels were not recorded as performed in crestal implantology as there is no osseointegration expected in these regions in a BOI implant. Subject assessment and quality of life was measured at every follow-up visit.

Inclusion criteria

1. Missing single tooth (healed edentulous site or fresh extraction site).

2. Adequate or inadequate bone volume at the edentulous site.

3. Minimum bone height of 2-3 mm and minimum bone width of 5-7 mm at the base of the edentulous site.

4. Smokers and non-smokers were included in this study.

5. Patients with and without periodontitis of any grade.

6. Skeletally mature and between 18-80 years age upon signing the informed consent form.

7. Willingness to participate in the duration of the study.

Exclusion criteria

1. Chemotherapy

2. Immunosuppressive therapy.

3. Leucopenia

4. Malignant haemopoietic disease.

5. Uncontrolled systemic disease.

6. Uncontrolled diabetes.

7. Bisphosphonate therapy.

8. Current use of medication known to cause gingival enlargement, such as Cyclosporine A, Nifidipine, or Phenytoin.

9. Evidence of severe parafunctional habits like clenching and grinding.

10. History of localised irradiation treatments in or near the proposed implant sites.

11. Pregnancy or likelihood of pregnancy during the study.

12. Patients with uncritical and negligient attitude towards life.

CASE HISTORY PROFORMA

Serial no : Register no :

Name : Age/Sex:

Address:

Contact no :

e-mail:

Chief complaint :

MEDICAL HISTORY

Diabetes mellitus:

Hypertension:

Cardiac problems:

Blood dyscrasias:

Neural disorder:

Liver disorder:

Thyroid disorder:

HIV:

H/O jaw fractures or jaw lesions:

Exposure to radiation:

Chemotherapy:

DRUG HISTORY

Allergies:

Anticoagulant drugs:

Antibiotics:

Other medications:

PERSONAL HISTORY

Habits

Smoking: Duration:

Alcohol: Duration:

Betel nut chewing: Duration:

Brushing: Duration:

CLINICAL EXAMINATION

B.P:

Pulse:

Respiratory rate:

Temperature:

State of edentulosness

Partially edentulous-

Kennedey's Classification:

Missing tooth/teeth:

Skeletal Jaw Relationship:

PRE-TREATMENT EVALUATION

Midlines:

Deviations:

Pain:

Elongation of teeth:

Posterior teeth:

Anterior teeth:

Deviation of Occlusal plane:

Lateralisation of dentition:

Vertical dimension:

Unilateral extractions:

Condylar angle:

AFMP angle (Planas Masticatory Functional angle) :

Diastemas:

Non-correctable dysfunctions:

Mouth opening:

Nature of soft tissue:

Conditions of standing teeth:

Oral hygiene:

Alveolar ridge conditions:

Palpation of implant site:

<u>Structural H/O implant site</u>

Any previous implants in the implant site:

Reason for loss:

Any recent extractions in the implant site:

Speech and Hearing function

Position of teeth:

Spatial relationship of tongue and other soft tissues:

Pattern of chewing:

Deviation of mandible:

Other observations:

Study Models

Mesiodistal width:

Interocclusal gap:

Radiographic evaluation

Available bone height: Radiographic height of available bone x clinical diameter of metallic ball / radiographic diameter of metallic ball

Relation of anatomical structures:

Available bone height (if CT available)

Pre-treatment procedure

Bone Mapping:

Available bone width:

Other observations:

INVESTIGATIONS

a)Radiological: OPG/Frontal Ceph/Lateral Ceph/IOPAS/CT

b)Systemic: TC,DC,Hb%,ESR,BT,CT,RBS,HbsAg, HIV I,II

c)Special investigations if any:

TREATMENT PLAN

A)Total number of implants:

B)Site of implant:

Size of implant:

Type of implant:

C)Any other procedure:

FOLLOW-UP

	1 day	1 wks	3 wks	6 wks	3 mon	6 mon	1yr
CLINICAL							
Plaque index							
Bone loss							
Mobility							
Condition of sorrounding tissues							
Condition of prosthesis							
Relationship of adjacent teeth							
Relationship of opposing teeth							
Pain/discomfort							
Paresthesia/numbness							
Aesthetics							
RADIOGRAPHIC							
Radiolucency							
Satus of Osseointegration							
PATIENT SATISFACTION							

Other problems:

MATERIALS AND METHODS

Patients

In this clinical study, 11 patients presenting with one missing tooth satisfying the inclusion and exclusion criteria, reporting in the Department of Oral and Maxillofacial Surgery, Ragas Dental College and Hospital, Chennai from 2010-2011 were selected. Informed consent was taken prior to surgery and the source data was collected in a proforma.(Table 1)

Diagnostic protocol

A comprehensive diagnostic assessment was performed. Clinically, alginate impressions were taken to fabricate the diagnostic casts and these were articulated. Bone mapping of the edentulous site was performed under local anesthesia and the measurements were transferred to saggitally sectioned plaster models to estimate the bone width and form.

Radiographically, an OPG was taken after insertion of a template containing a metallic ball of a fixed diameter to eliminate the magnification error and estimate the available bone height at the edentulous site. Also, an IOPA radiograph of the edentulous site by using a standardised paralleling cone technique with a film holder and an aiming device was taken.

Surgical protocol

This implant was placed in the edentulous locations under local anaesthesia (2% lignocaine with 1:80,000 adrenaline), by local infiltration. After raising a full thickness flap, the implant bed was created through lateral access using vertical cutters, horizontal cutters and combination cutters. The first vertical bone cut was performed with tungsten carbide cutter to avoid unneccesary wear of the vertical

cutter. The preparation was performed using an high speed aerotor handpiece for the vertical cut and a reduction gear contra-angle handpiece at a speed of 3000rpm with copious irrigation. Next, the combination cutter was used to create the initial lateral cut and refine the vertical cut creating a path of insertion for the implant. This was followed by the lateral cutter which enlarged the lateral cut according to the implant size and type used. For double or triple disk BOI implant, an additional double-disk cutter was used to maintain the distance between the crestal and the basal disk. Subsequently the basal cut was widened according to the diameter of the basal disk. In case of triple disc BOI implant, the double disk cutter was used twice, with the cuts overlapping each other to create the third slot. The implant size and type (depending on number of disks as single disk, double disk and triple disk) were selected depending on the amount of bone available. More than one disk was preferred in cases with sufficient bone as it would provide better cortical anchorage and stability of the implant. Once the vertical and lateral bone cuts were created, the implant was inserted through a lateral access using carefully dosed hammer style strokes with a pencil osteotome and mallet. The rectangular side of the basal disk faces the vestibular aspect and the rounded side remained on the medial aspect. The presence of sufficient support was verified visually and manually by testing with fingers. Any part of the projecting disk was then bent and adapted to the bone surface. In cases where there was a bony defect left behind, the implant surface was covered on its buccal/labial side with particulate alloplastic graft followed by placement of a resorbable membrane. However this was done for esthetic areas only like the maxillary anterior region as primary stability was not a problem with these implants. Sterile Ringer's lactate was used as a cooling medium as it is said to be more benign than saline. Horizontal mattress sutures were placed for closure using 3-0 silk or 4-0

vicryl suture material in case of esthetic areas where simultaneous bone grafting was done.

Post-surgical protocol

All patients were administered with a single dose of steroid (Inj.Decdan 8mg) and analgesic (Inj.Voveran 75mg) intramuscularly, immediately after the procedure. They were also prescribed a regime of oral antibiotics (Cap.Amoxicillin 500mg, TDS; Tab. Metrogyl 400mg TDS), analgesics (Tab.Imol, BD) and H2 receptor antagonist (Tab. Rantac 150 mg, BD) for a period of 5 days. They were advised to perform ice-pack application extraorally over the surgical site for a period of 48 hours in an intermittent fashion. Then onwards, they were encouraged to perform warm saline mouth rinses daily. Suture removal was done for all patients on the 5^{th} post-operative day.

Restorative protocol

Impressions were made for provisional restoration immediately after insertion of the implant within 2-3 hours duration and the implants were provisionalised with a non-occluding prosthesis on the same day for most of the cases, with self cure crown and bridge acrylic material. Only, two patients were delivered the prosthesis the next day. The provisional crowns were cemented to the abutments with a temporary cement (EBA modified Zinc oxide Eugenol cement material) .

Three months later, the implants was definitively restored with fully occluding ceramometal restoration after thorough clinical and radiographic evaluation as mentioned in the follow-up protocol below.

All patients were instructed to avoid any occlusal loading over the implant immediately after placement and for a period of 3 months, after which they were

asked to subject the implant to moderate loading forces only, initially. A gradual increase in loading was advised, till the osseointegration period was complete (approximately one year).

Follow-up protocol

Clinical and radiographic data was collected at 1day, 1week, 3weeks, 1month, 3months, 6months and 12months follow-up appointments and the data collected was tabulated. Clinical evaluation was done by: manual pressure and percussion of the implant, status of peri-implant gingiva, status of adjacent and opposing teeth, oral hygiene.

Standardised radiographic assessments was done by: IOPA radiograph of the implant site using the standardised paralleling cone technique with a film holder and an aiming device, to rule out presence of implant mobility or peri-implant radiolucency. Peri-implant marginal bone levels were not recorded as performed in crestal implantology as there is no osseointegration expected in these regions in a BOI implant. Subject assessment and quality of life was measured at every follow-up visit.

INCLUSION CRITERIA

1)Missing single tooth (healed edentulous site or fresh extraction site).

2) Adequate or inadequate bone volume at the edentulous site. 2)

3) Minimum bone height of 2-3mm and minimum bone width of 5-7mm at the base of the edentulous site.

4)Smokers and non-smokers were included in this study.

5) Patients with and without periodontitis of any grade.

5)Skeletally mature and between 18-80 years age upon signing the informed consent form.

6)Willingness to participate in the duration of the study.

EXCLUSION CRITERIA

1)Chemotherapy

2)Immunosuppressive therapy.

3)Leucopenia

4)Malignant haemopoietic disease.

5)Uncontrolled systemic disease.

6)Uncontrolled diabetes.

7)Bisphosphonate therapy.

8)Current use of medication known to cause gingival enlargement, such as Cyclosporine A, Nifidipine, or Phenytoin.

9)Evidence of severe parafunctional habits like clenching and grinding.

10)History of localised irradiation treatments in or near the proposed implant sites.

11)Pregnancy or likelihood of pregnancy during the sudy.

12)Patients with uncritical and negligient attitude towards life.

CASE HISTORY PROFORMA

Serial no : Register no :

Name : Age/Sex:

Address:

Contact no :

e-mail:

Chief complaint :

MEDICAL HISTORY

Diabetes mellitus:

Hypertension:

Cardiac problems:

Blood dyscrasias:

Neural disorder:

Liver disorder:

Thyroid disorder:

HIV:

H/O jaw fractures or jaw lesions:

Exposure to radiation:

Chemotherapy:

DRUG HISTORY

Allergies:

Anticoagulant drugs:

Antibiotics:

Other medications:

PERSONAL HISTORY

Habits

Smoking: Duration:

Alcohol: Duration:

Betel nut chewing: Duration:

Brushing: Duration:

CLINICAL EXAMINATION

B.P:

Pulse:

Respiratory rate:

Temperature:

State of edentulosness

Partially edentulous-

Kennedey's Classification:

Missing tooth/teeth:

Skeletal Jaw Relationship:

PRE-TREATMENT EVALUATION

Midlines:

Deviations:

Pain:

Elongation of teeth:

Posterior teeth:

Anterior teeth:

Deviation of Occlusal plane:

Lateralisation of dentition:

Vertical dimension:

Unilateral extractions:

Condylar angle:

AFMP angle (Planas Masticatory Functional angle) :

Diastemas:

Non-correctable dysfunctions:

Mouth opening:

Nature of soft tissue:

Conditions of standing teeth:

Oral hygiene:

Alveolar ridge conditions:

Palpation of implant site:

Structural H/O implant site

Any previous implants in the implant site:

Reason for loss:

Any recent extractions in the implant site:

Speech and Hearing function

Position of teeth:

Spatial relationship of tongue and other soft tissues:

Pattern of chewing:

Deviation of mandible:

Other observations:

Study Models

Mesiodistal width:

Interocclusal gap:

Radiographic evaluation

Available bone height: Radiographic height of available bone x clinical diameter of metallic ball / radiographic diameter of metallic ball

Relation of anatomical structures:

Available bone height (if CT available)

Pre-treatment procedure

Bone Mapping:

Available bone width:

Other observations:

INVESTIGATIONS

a)Radiological: OPG/Frontal Ceph/Lateral Ceph/IOPAS/CT

b)Systemic: TC,DC,Hb%,ESR,BT,CT,RBS,HbsAg, HIV I,II

c)Special investigations if any:

TREATMENT PLAN

A)Total number of implants:

B)Site of implant:

Size of implant:

Type of implant:

C)Any other procedure:

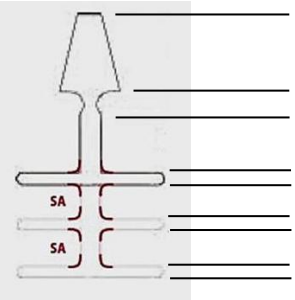
FOLLOW-UP

	1 day	1 wks	3 wks	6 wks	3 mon	6 mon	1yr
CLINICAL							
Plaque index							
Bone loss							
Mobility							
Condition of sorrounding tissues							
Condition of prosthesis							
Relationship of adjacent teeth							
Relationship of opposing teeth							
Pain/discomfort							
Paresthesia/numbness							
Aesthetics							
RADIOGRAPHIC							
Radiolucency							
Satus of Osseointegration							
PATIENT SATISFACTION							

Other problems:

DESCRIPTION OF BOI-IMPLANTS

NOMENCLATURE



IMPLANT HEAD: sandblasted head with standard height of 7.2mm and width of 3.5mm

SOFT TISSUE COLLAR: polished, having standard height of 1.8mm

SHAFT: polished, with standard diameter of 2mm and variable height (H) in mm

SA: Distance between disks available as 3mm unless specified as 'X' with distance of 5mm

SH 1-3: Disk height (individual disks). It is variable depending on type of implant

BS: Single disk BOI with antirotational cube shaped disk

Eg: BS 7: Disk diameter 7mm

DESCRIPTION	H	SH1	SH2	SH3	SA
BS 7	H 8	0.7-0.9			
BS 7	H 12	0.7-0.9			
BS 9	H 6	0.7-0.9			
BS 10	H 4	0.7-0.9			
BS 10	H 6	0.7-0.9			
BS 10	H 10	0.7-0.9			
BS 12	H 6	0.7-0.9			
BS 12	H 8	0.7-0.9			
BS 12	H 10	0.7-0.9			
BS 12	H 12	0.7-0.9			

BOI – BAST

Eg: BAST 10/16: average width of 10mm and length of 16mm

With cogs on flat side and may be rotated after placement

DESCRIPTION	H	SH1	SH2	SH3	GD
BAST 10/16	H 4	0.7-0.9			9.5
BAST 10/12	H 6	0.7-0.9			9.5
BAST 10/16	H 6	0.7-0.9			9.5
BAST 10/14	H 8	0.7-0.9			9.5
BAST 10/16	H 8	0.7-0.9			9.5

GD: maximum diameter on round side in mm

In red - Implant types used in this study

BOI - BAS 9/12 was used in two cases - currently not available

BOI – BBS

Eg: BBS 9/7: diameter of basal disk 9mm, diameter of crestal disk 7mm

DESCRIPTION	H	SH1	SH2	SH3	SA
BBS 7	H 6	0.7-0.9	0.7		3
BBS 9/7	H 6	0.7-0.9	0.7		3
BBS 9/7	H 10	0.7-0.9	0.7		3
BBS 9/7	H 8	0.7-0.9	0.7		3
BBS 10	H 4	0.7-0.9	0.7		3

BOI – BBBS

Eg: BBBS 7: diameter of all disks 7mm

DESCRIPTION	H	SH1	SH2	SH3	SA
BBBS 7	H 4	0.6	0.6	0.6	3
BBBS 7	H 6	0.6	0.6	0.6	3
BBBS 7	H 8	0.6	0.6	0.6	3

BOI - BAC

Used in severely atrophic areas, also can be used as a subperiosteal implant

BOI - DISKOS 4T

BOI implant with asymmetric disks for use in areas with reduced mesiodistal width

In red - Implant types used in this study

CUTTERS FOR BOI

VERTICAL CUTTER

Description	L	SH	SA	DV
VC 1.9	32			1.9
VC 1.6	32			1.6

COMBINATION CUTTER

Description	L	SH	SA	DV
KC 7-4W	32	0.4		7
KC 8-4W	32	0.4		8
KCD 7-4W	32	0.4	3	7
KCXD	32	0.6	5	9

LATERAL CUTTER - Single

Description	L	SH	SA	DV
LC 7-4W	32	0.4		7
LC 7-6W	32	0.6		7
LC 7-8W	32	0.8		7
LC 8-4W	32	0.4		8
LC 9-4W	32	0.4		9
LC 9-6W	32	0.6		9
LC 9-8W	32	0.8		9
LC 9-10W	32	1.0		9
LC 10-4W	32	0.4		10
LC 10-6W	32	0.6		10
LC 10-8W	32	0.8		10
LC 12-4W	32	0.4		12
LC 12-6W	32	0.6		12

LATERAL CUTTER - Double

Description	L	SH	SA	DV
LCD 7-4W	32	0.4	3	7

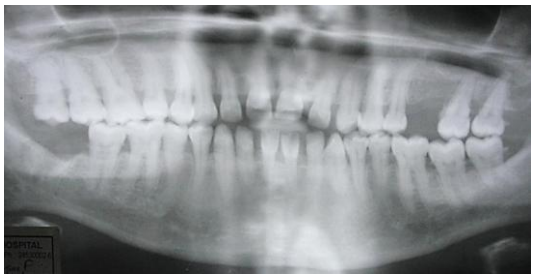
LATERAL CUTTER - Triple

Description	L	SH	SA	DV
LCT 7-4W	32	0.4	3	7

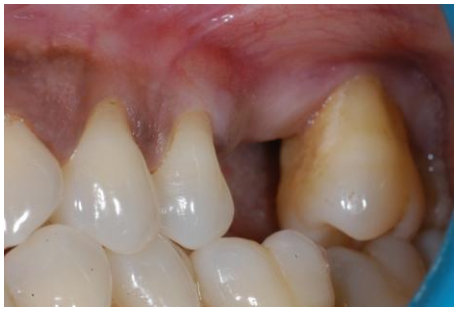
MAXILLARY POSTERIOR IMPLANT PLACEMENT

PRE – OPERATIVE PHOTOGRAPHS

OPG

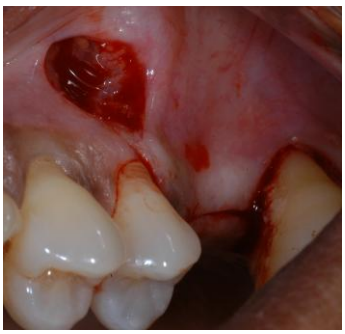


Photo

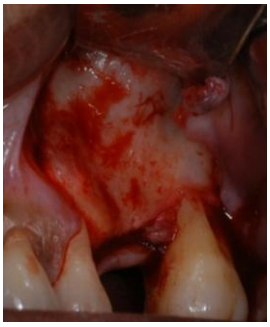


INTRA-OPERATIVE PHOTOS

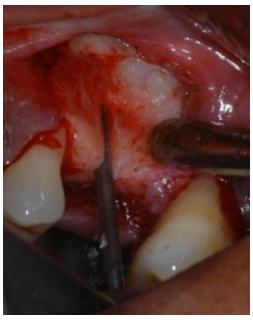
Incision



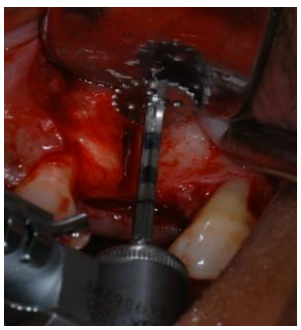
Exposure



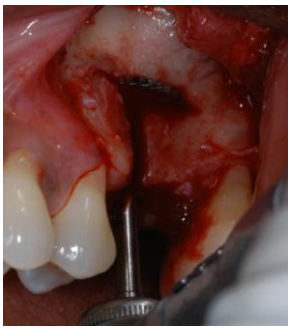
Vertical cut using VC 1.6



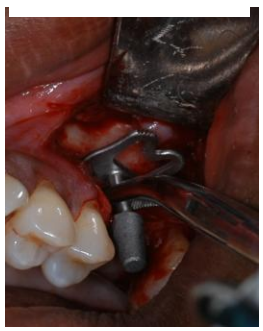
Combination cut - Vertical and Lateral using KC 7



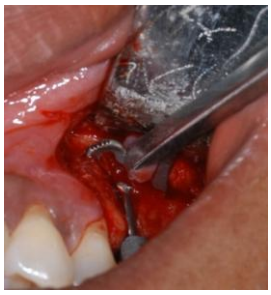
Lateral cut using LC 9-6W



BOI BAS 9/12,H6 placement

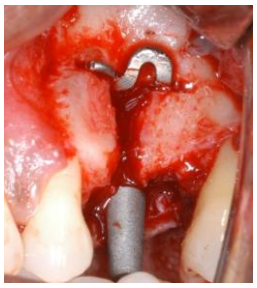


Insertion of the implant

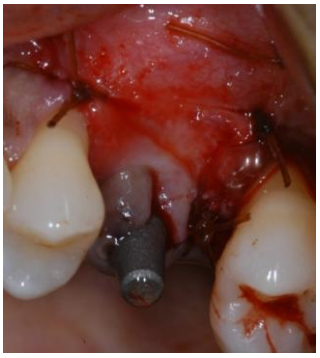


Bending of the protruding disc

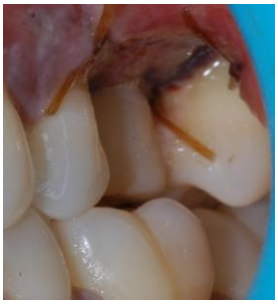
Implant insertion complete



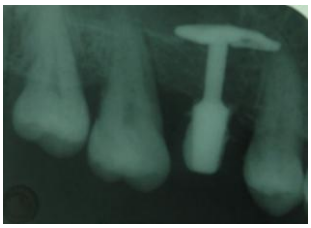
Closure



Immediate restoration with acrylic crown

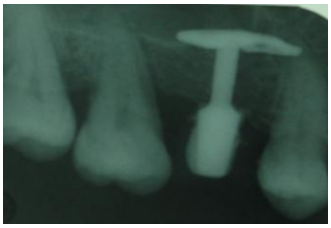


Immediate post-operative IOPA

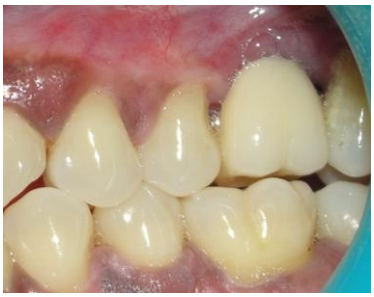


17 MONTHS POST-OPERATIVE PHOTOS

IOPA



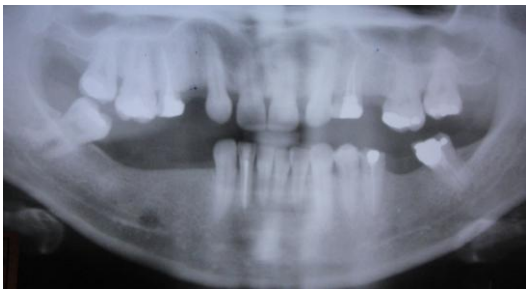
Clinical Photo with final ceramic restoration



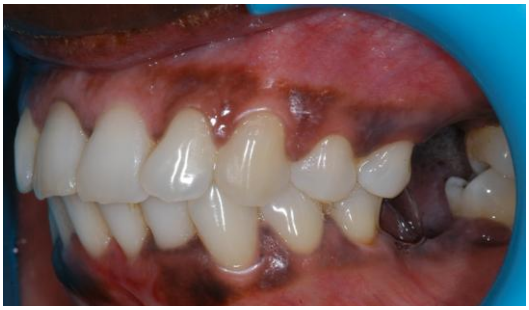
MANDIBULAR POSTERIOR BOI IMPLANT PLACEMENT

PRE – OPERATIVE PHOTOGRAPHS

OPG

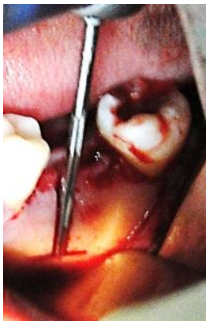


Photo



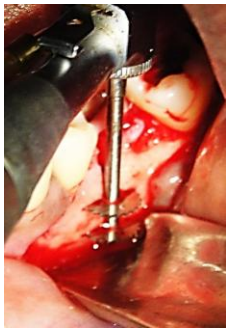
INTRA-OPERATIVE PHOTOGRAPHS

Vertical cut using
VC 1.6

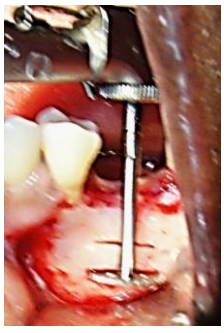


Vertical and lateral cut
(basal) using KC 7

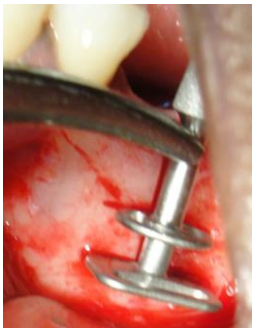
Double disk lateral
cut using LCD 7



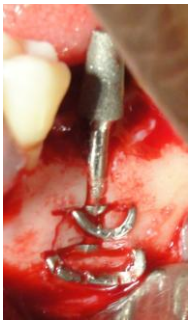
Lateral cut using LC 9-6W
for basal cut



Insertion of BOI
BBS 9/7,h6

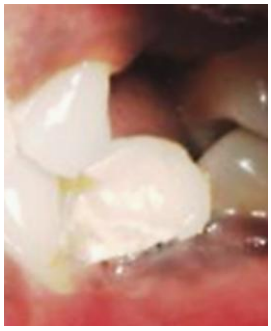


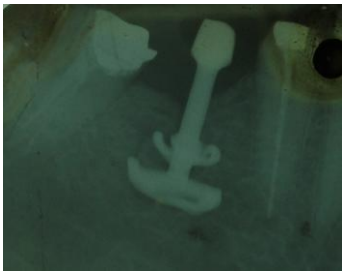
Implant insertion
complete



oration
with acrylic crown

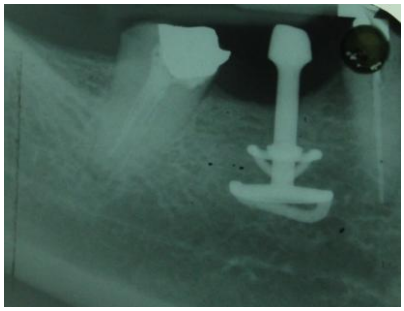
Immediate post-
operative IOPA



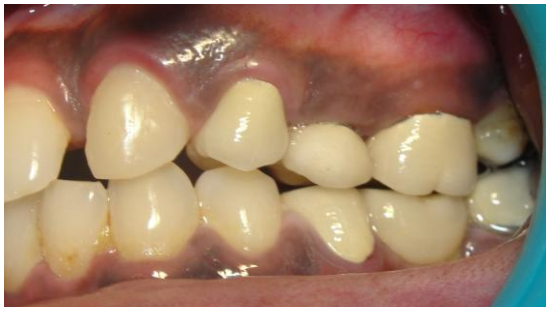


16 MONTHS POST-OPERATIVE PHOTOGRAPH

IOPA



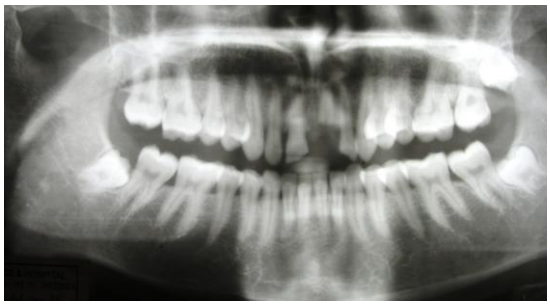
CLINICAL



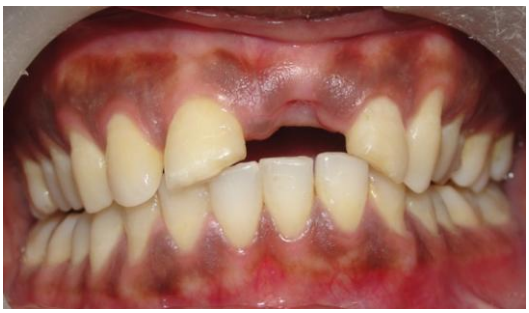
MAXILLARY ANTERIOR BOI IMPLANT PLACEMENT

PRE-OPERATIVE PHOTOGRAPHS

OPG

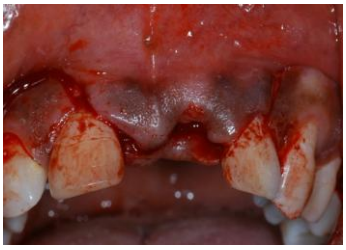


PRE-OPERATIVE PHOTOGRAPH

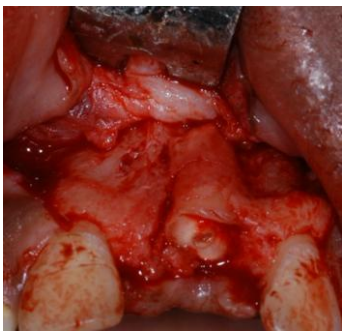


INTRA-OPERATIVE PHOTOGRAPHS

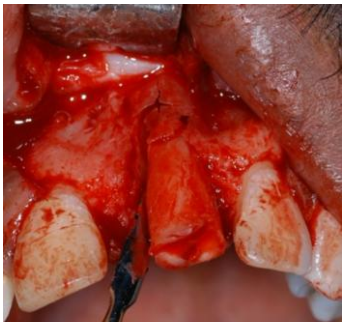
Incision



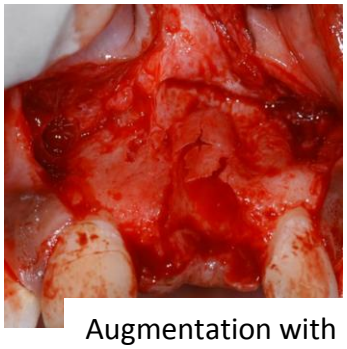
Exposure



Extraction of root stump

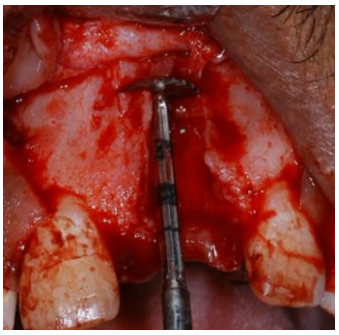


Loss of labial cortical plate



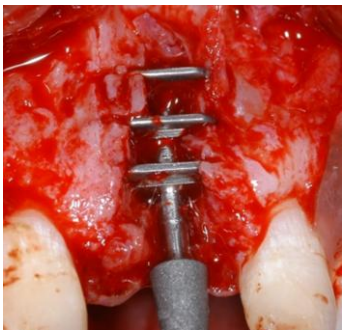
Augmentation with hydroxyapatite graft

Lateral cuts placed using KC7 and LCD 7

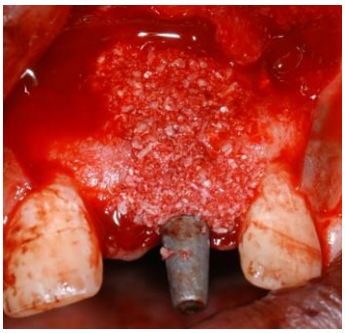


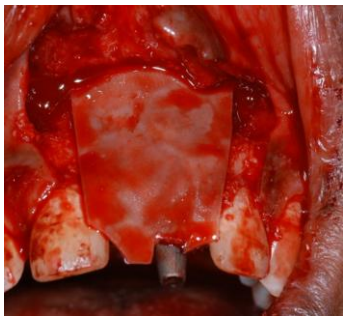
Defect covered with resorbable membrane

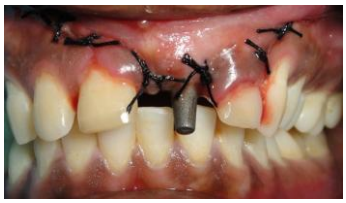
Insertion of BOI



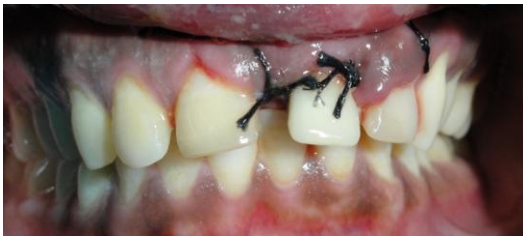
Closure



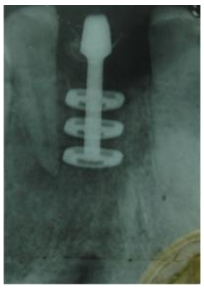




Immediate restoration with

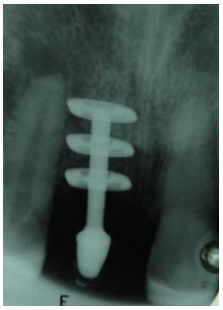


Immediate post-operative IOPA

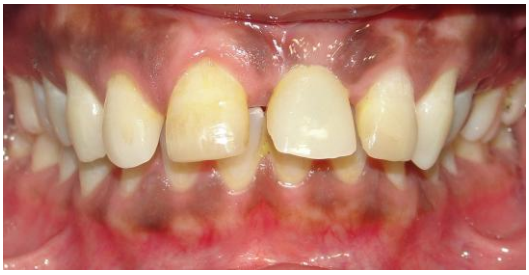


16 MONTHS POST-OPERATIVE PHOTOGRAPHS

IOPA



Restoration in place

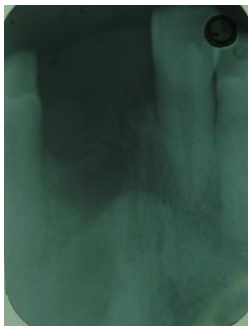


MAXILLARY ANTERIOR BOI IMPLANT PLACEMENT IN A CASE OF

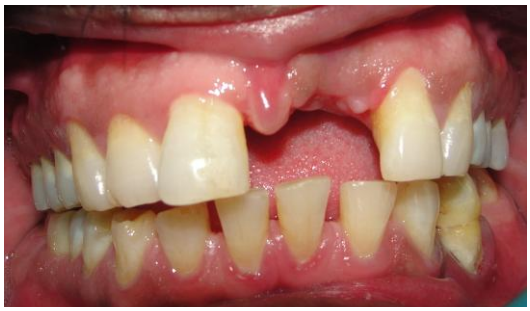
SEVERE BONE LOSS

PRE-OPERATIVE PHOTOGRAPHS

IOPA

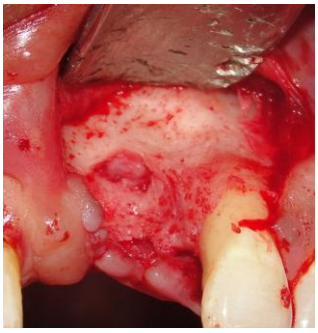


Clinical photograph

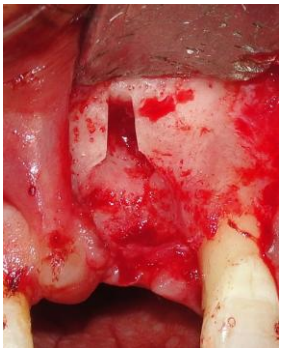


INTRA-OPERATIVE PHOTOGRAPHS

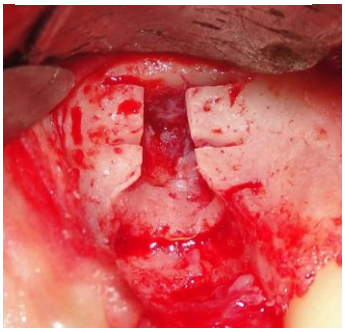
Exposure of the defect



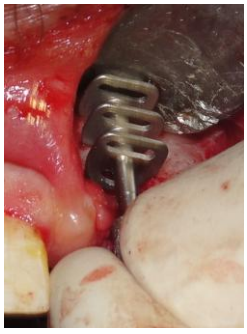
Vertical cut placed using VC 1.6



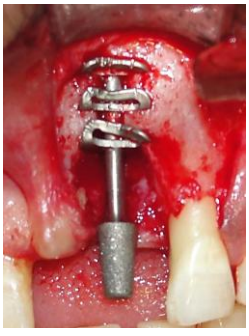
Lateral cuts placed using LCD 7



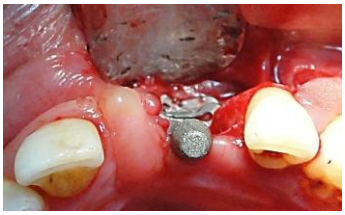
Insertion of BOI BBS 7, h6



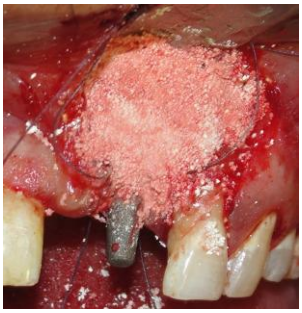
Insertion complete



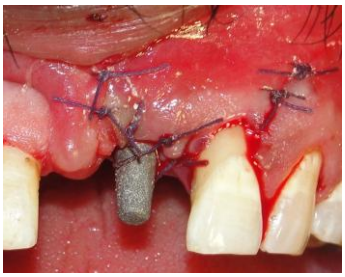
Labial contour



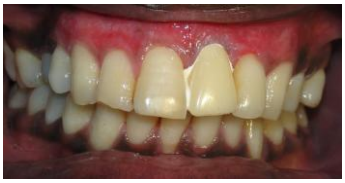
Augmentation with alloplastic bone graft



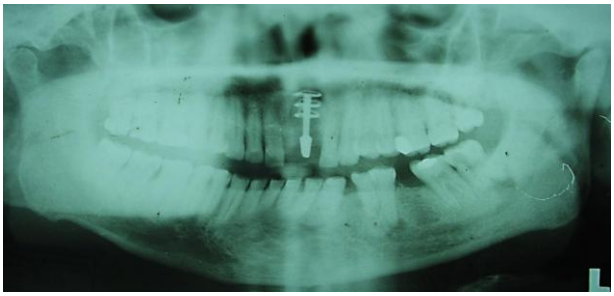
Closure



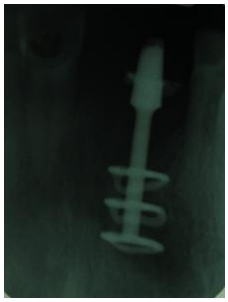
Immediate restoration with acrylic crown

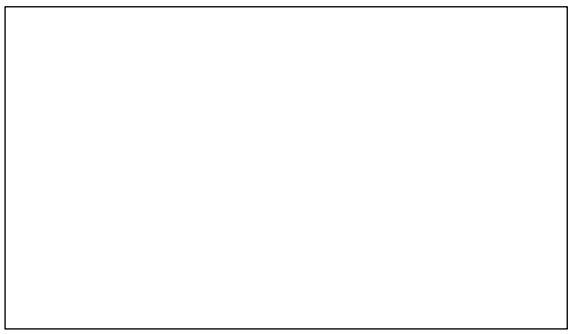


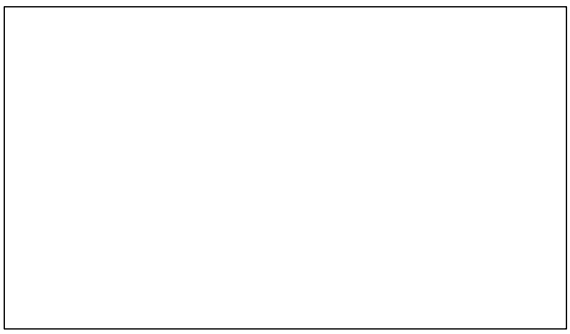
Immediate post-operative OPG

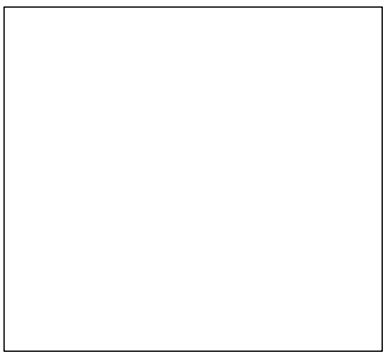


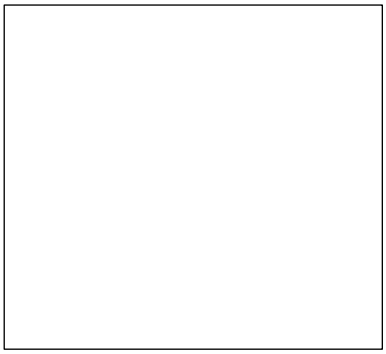
Immediate post-operative IOPA

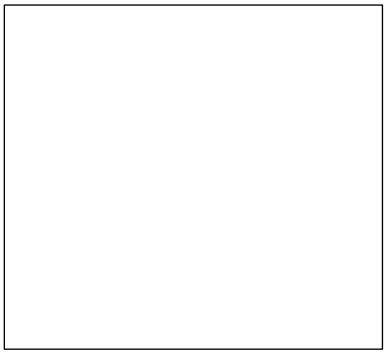


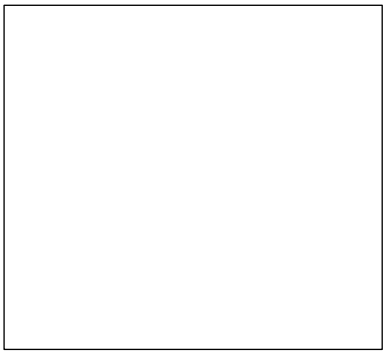




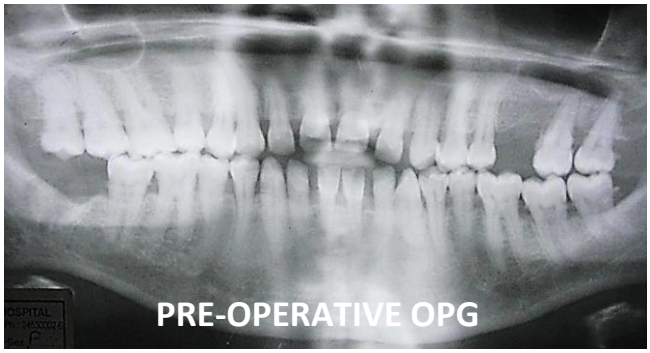




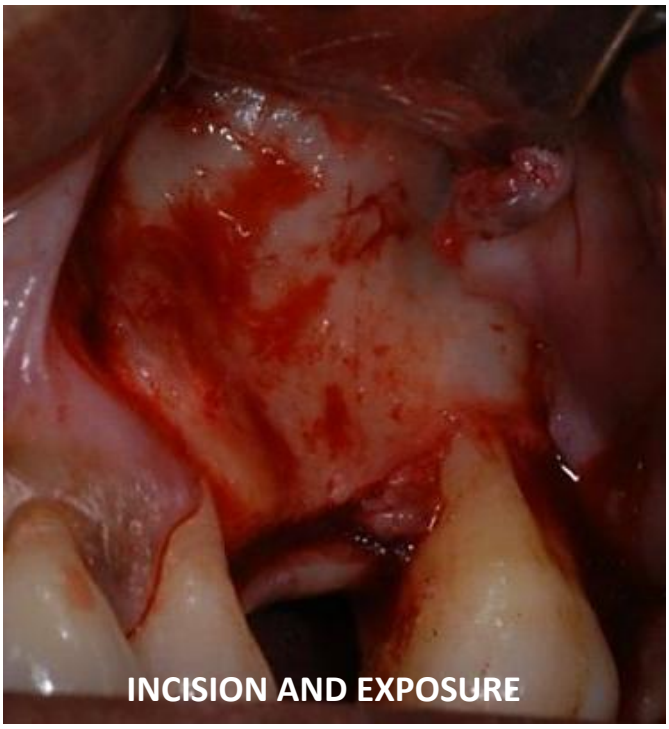


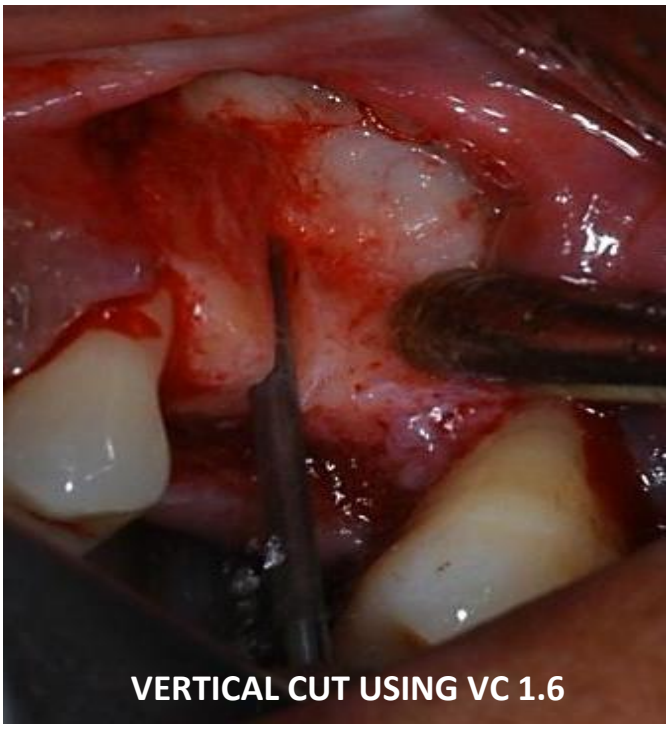


MAXILLARY POSTERIOR BOI IMPLANT PLACEMENT

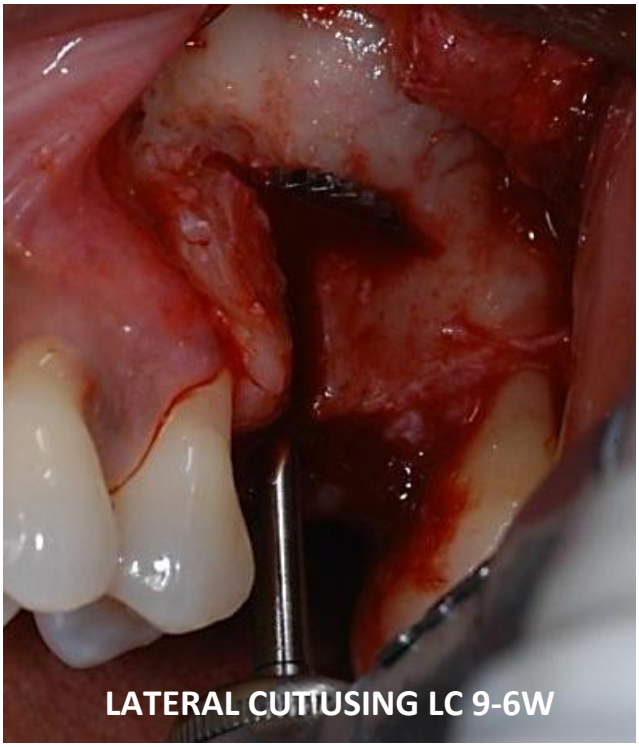

PRE-OPERATIVE OPG


PRE-OPERATIVE PHOTOGRAPH

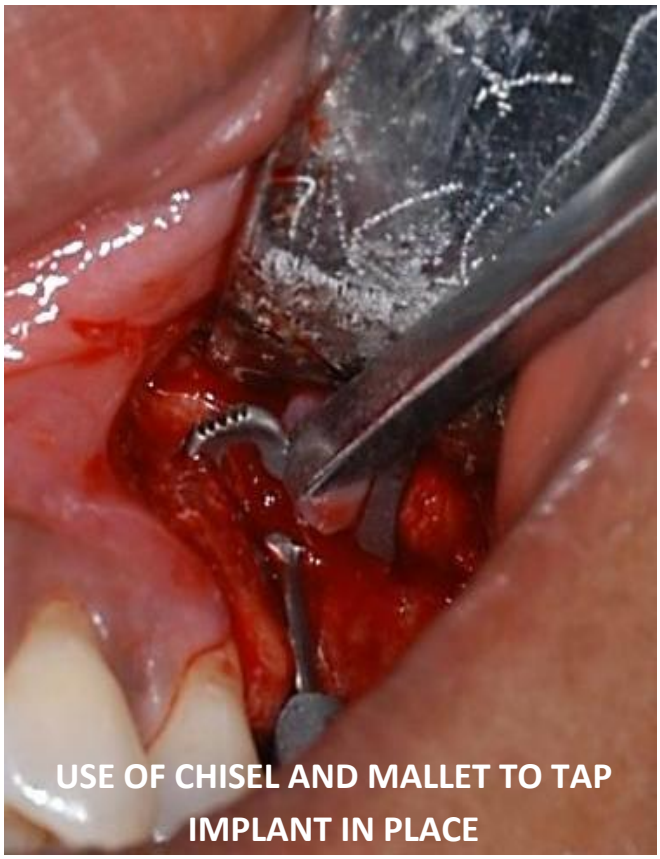

INCISION AND EXPOSURE


VERTICAL CUT USING VC 1.6

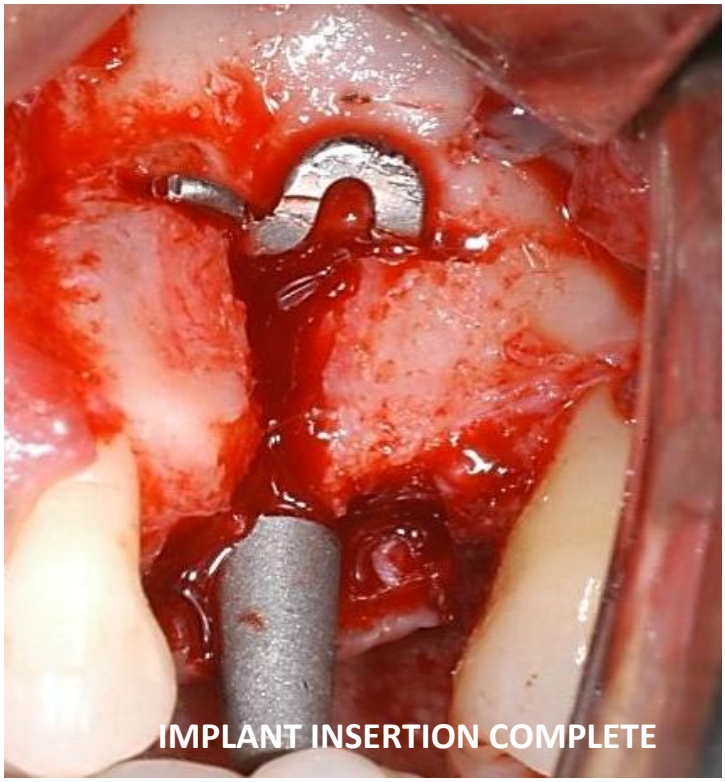

COMBINATION CUT USING KC 7


LATERAL CUTIUSING LC 9-6W

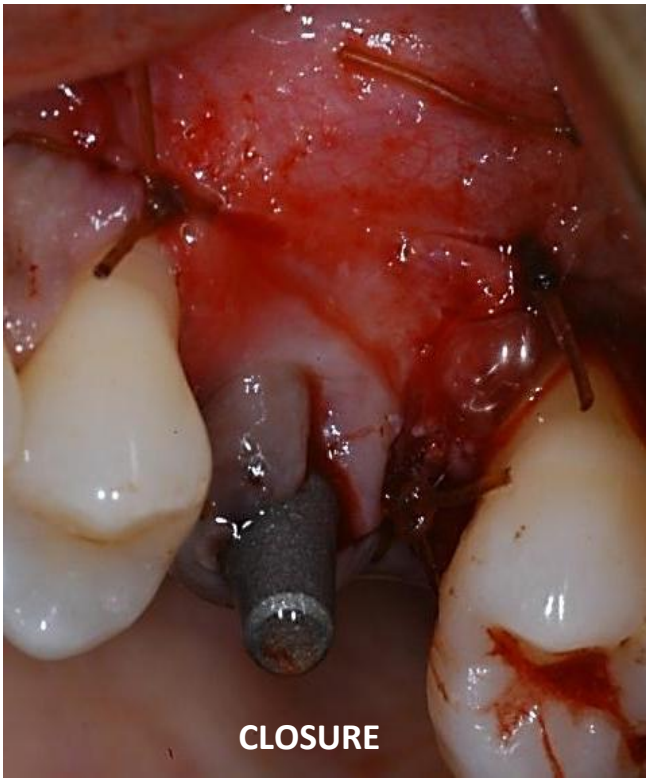
INSERTION OF BOI, BAS 9/12,h6



USE OF CHISEL AND MALLET TO TAP IMPLANT IN PLACE

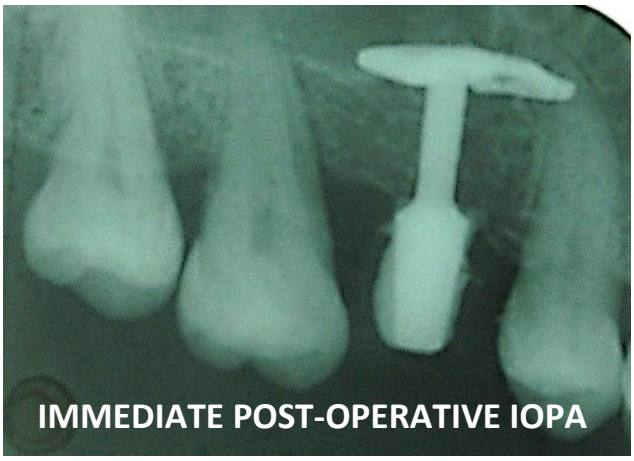


IMPLANT INSERTION COMPLETE

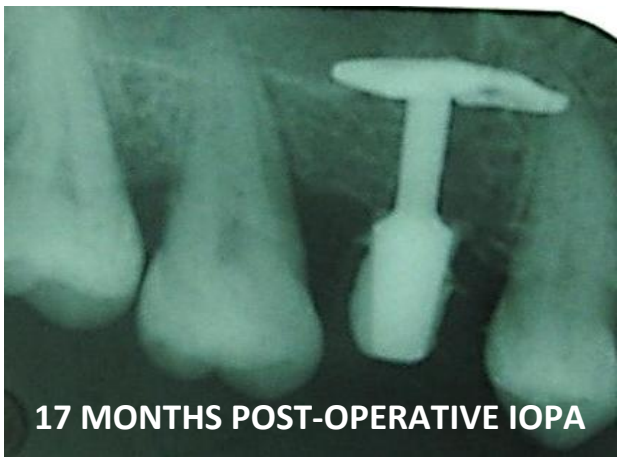


CLOSURE

IMMEDIATE RESTORATION WITH ACRYLIC CROWN



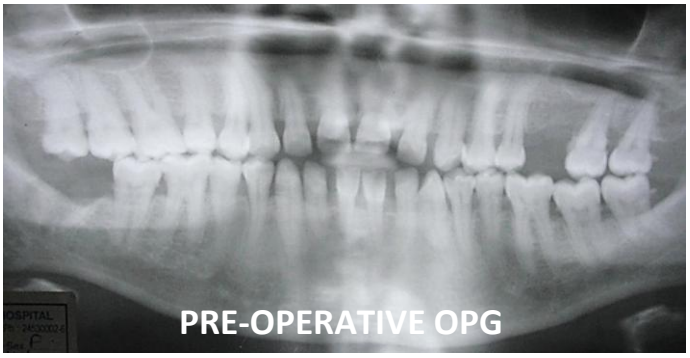
IMMEDIATE POST-OPERATIVE IOPA



17 MONTHS POST-OPERATIVE IOPA

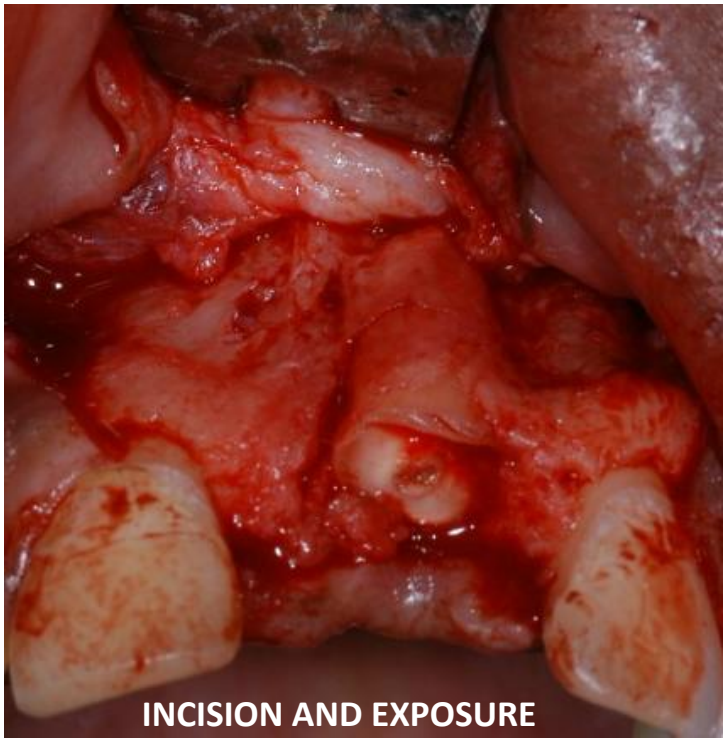
17 MONTHS POST-OPERATIVE PHOTOGRAPH WITH CERAMIC CROWN

MAXILLARY ANTERIOR BOI IMPLANT PLACEMENT

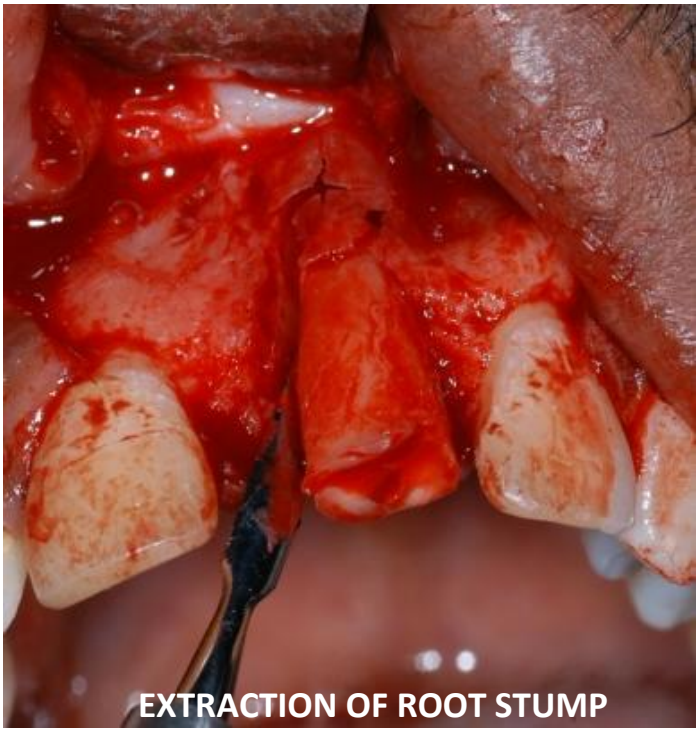


PRE-OPERATIVE OPG

PRE-OPERATIVE PHOTOGRAPH

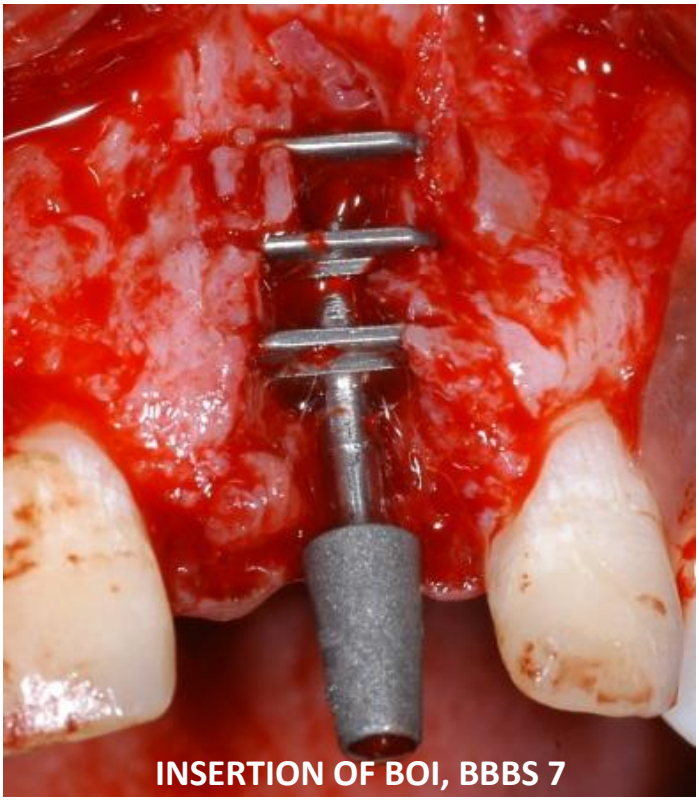


INCISION AND EXPOSURE

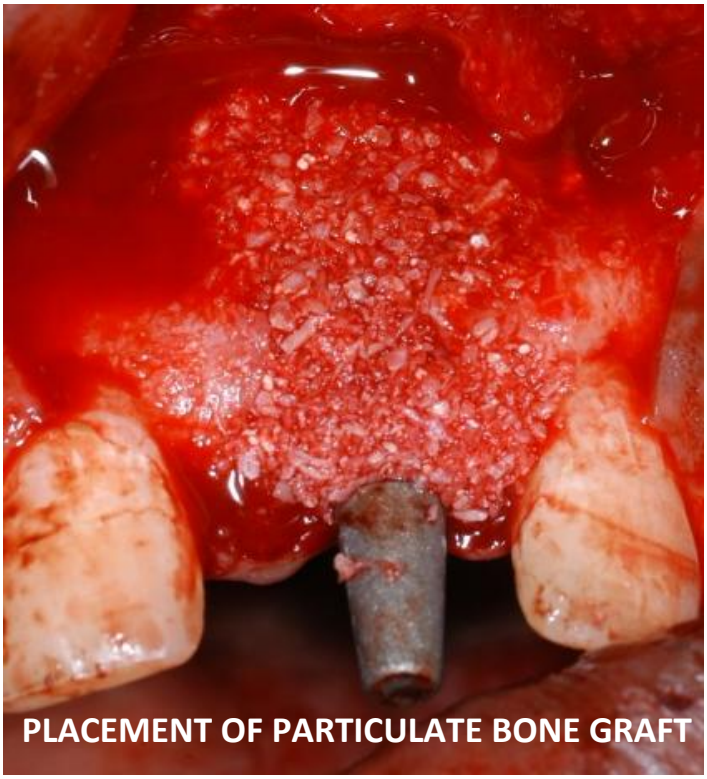


EXTRACTION OF ROOT STUMP

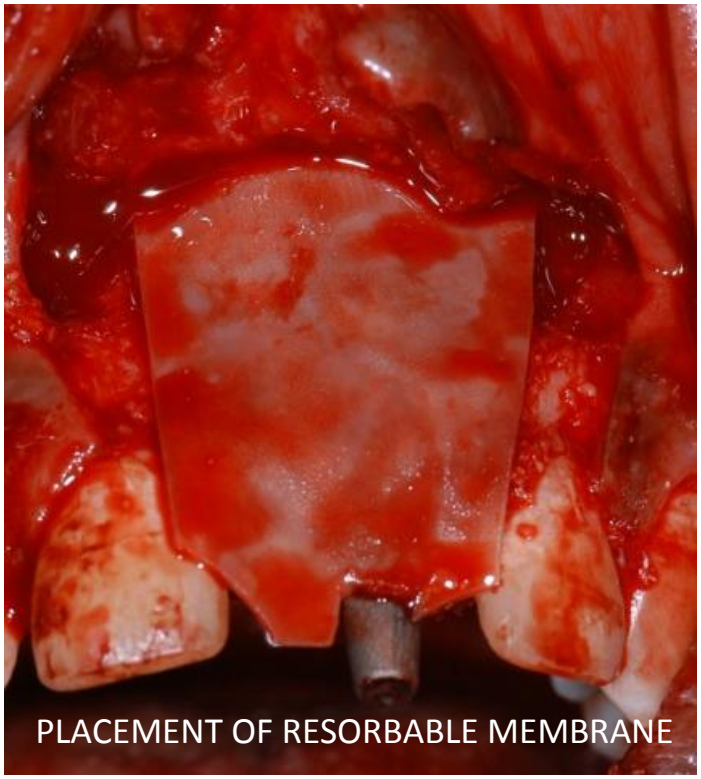
LATERAL CUT USING KC 7 AND LCD 7-4W



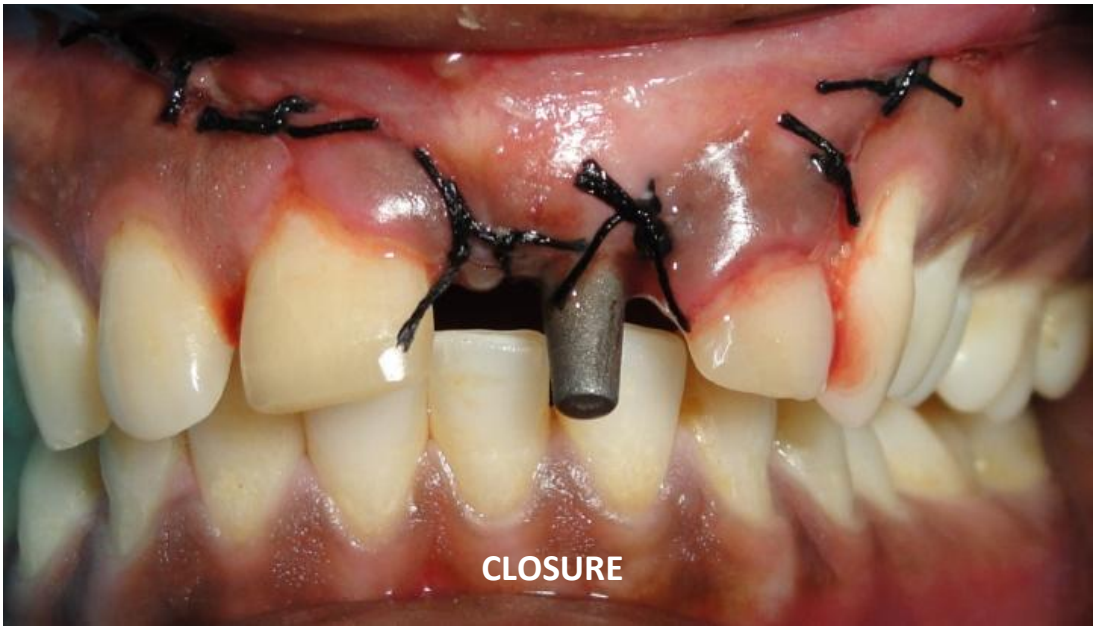
INSERTION OF BOI, BBBS 7



PLACEMENT OF PARTICULATE BONE GRAFT

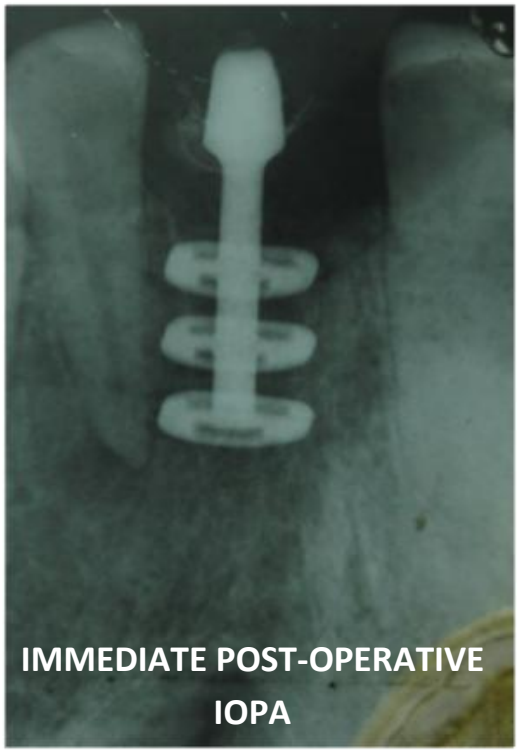


PLACEMENT OF RESORBABLE MEMBRANE

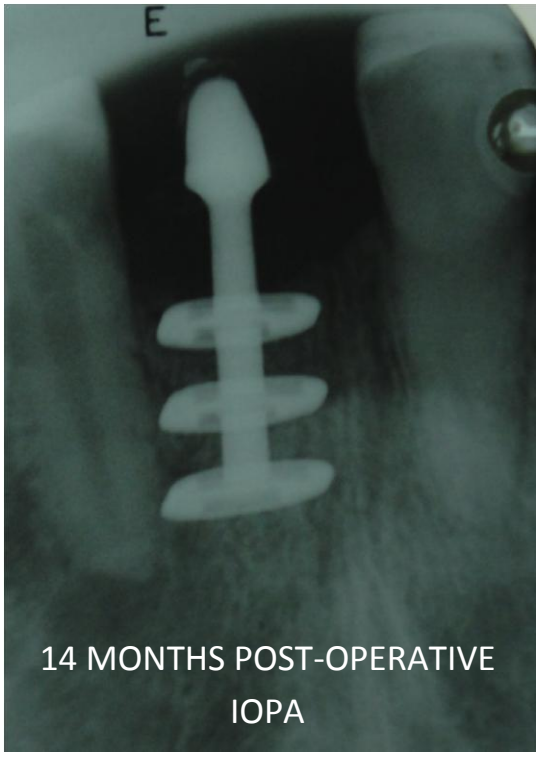


CLOSURE

IMMEDIATE RESTORATION WITH ACRYLIC CROWN



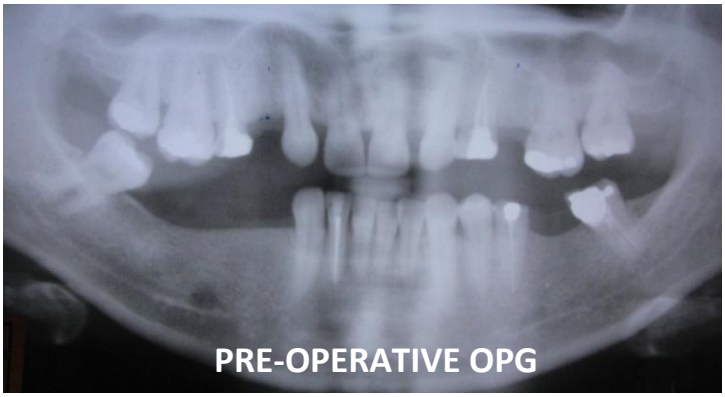
IMMEDIATE POST-OPERATIVE IOPA



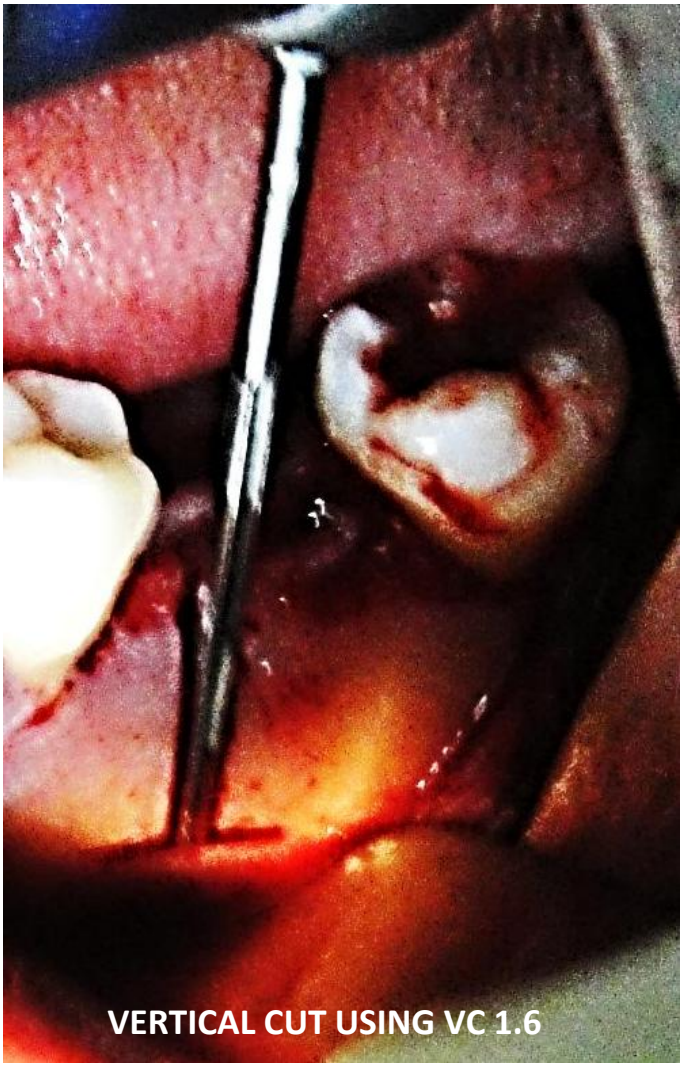
14 MONTHS POST-OPERATIVE IOPA

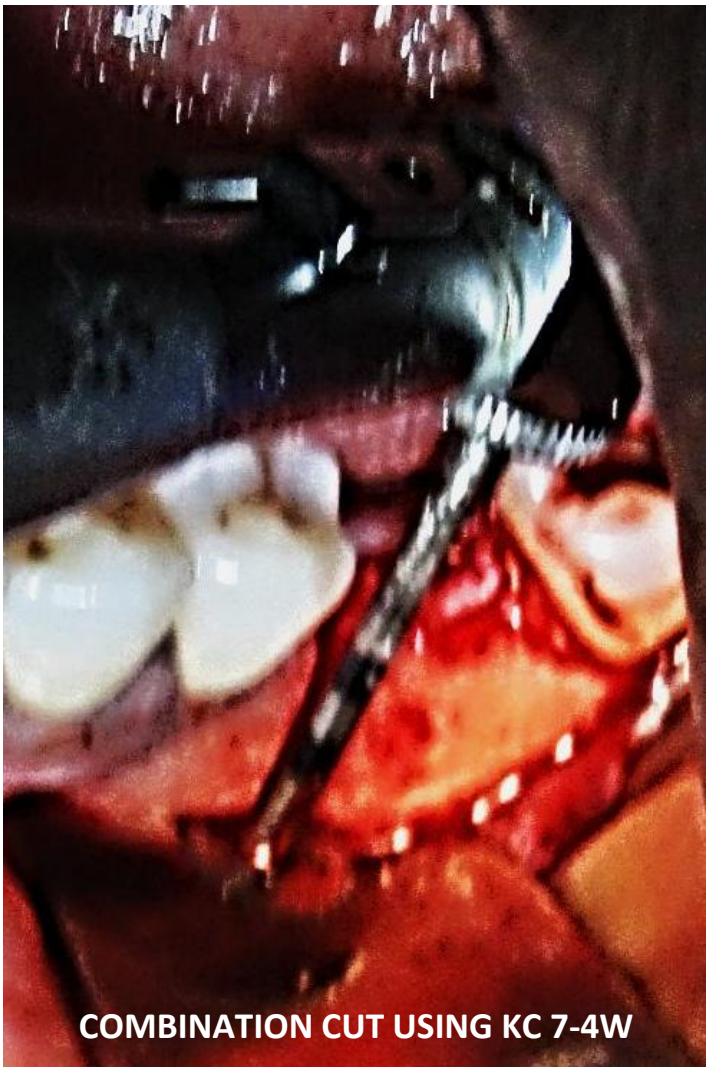
14 MONTHS POST-OPERATIVE PHOTOGRAPH

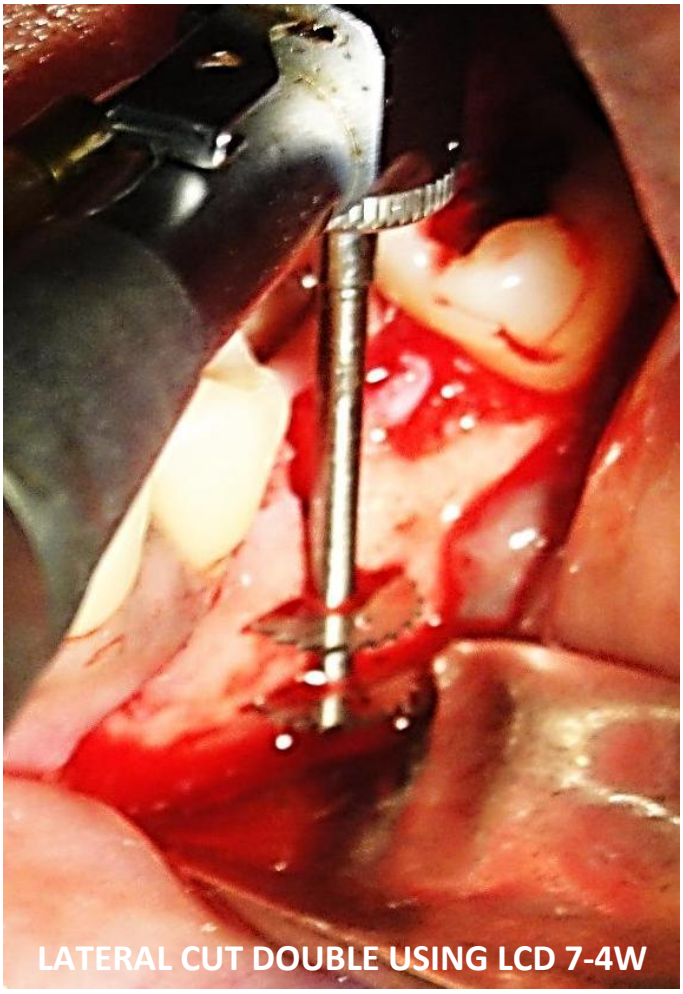
MANDIBULAR POSTERIOR BOI IMPLANT PLACEMENT


PRE-OPERATIVE OPG

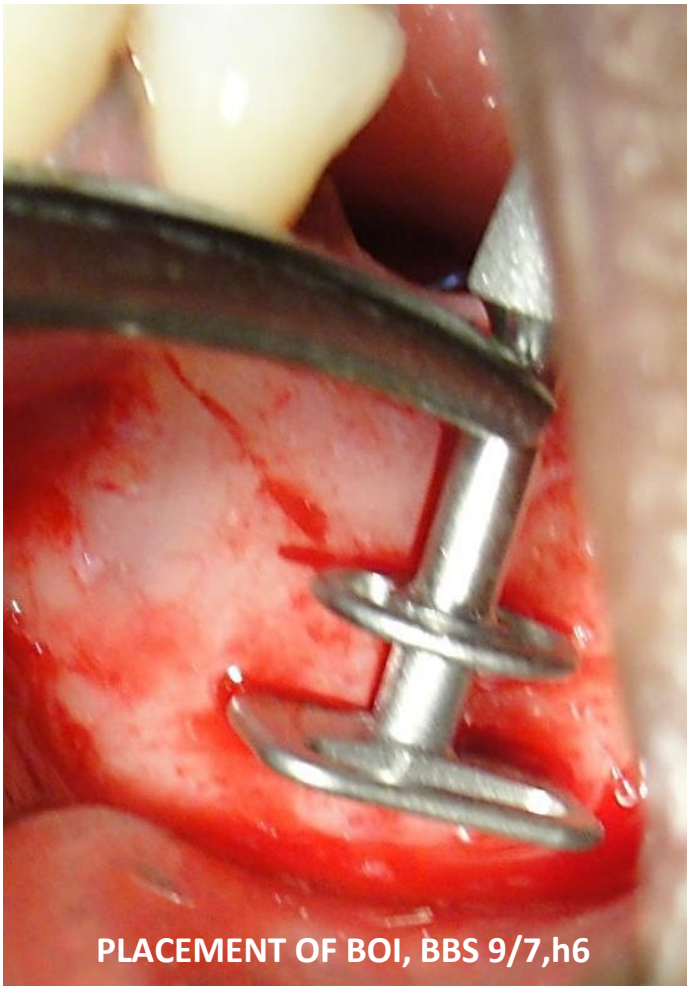

PRE-OPERATIVE PHOTOGRAPH


VERTICAL CUT USING VC 1.6

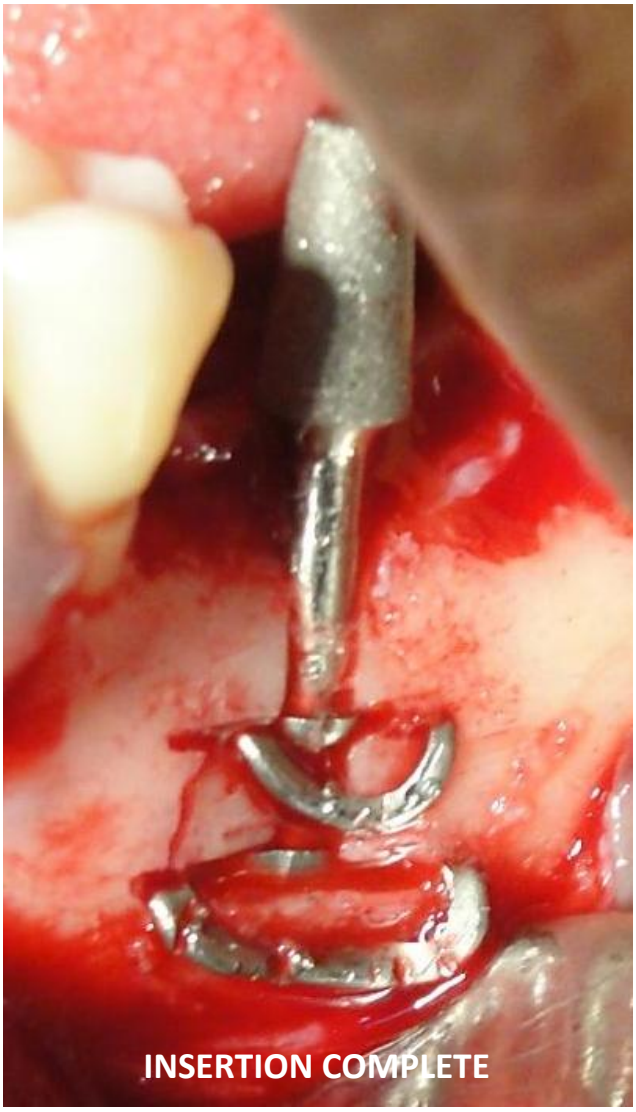

COMBINATION CUT USING KC 7-4W



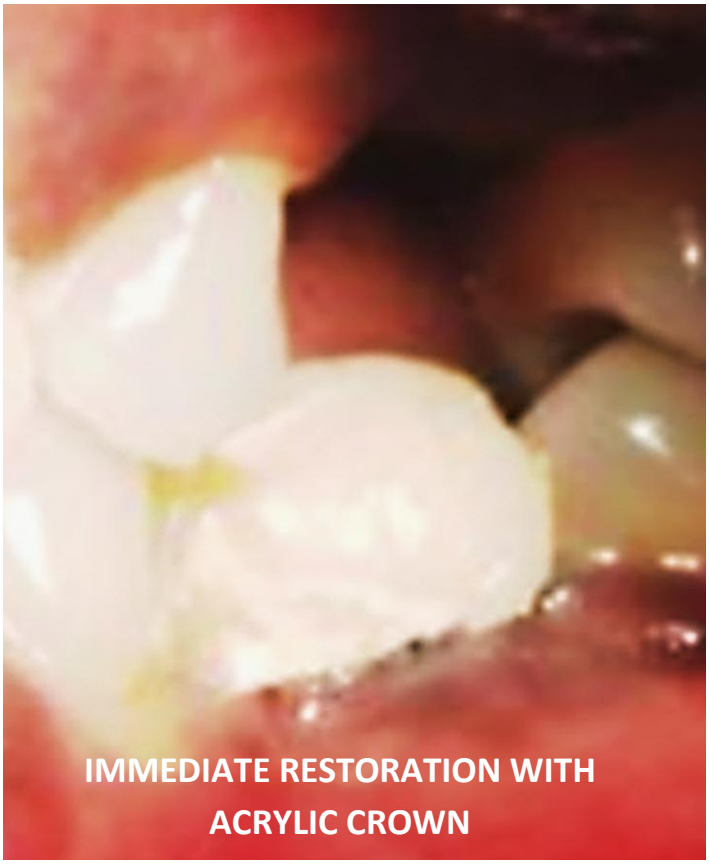
LATERAL CUT DOUBLE USING LCD 7-4W



PLACEMENT OF BOI, BBS 9/7,h6

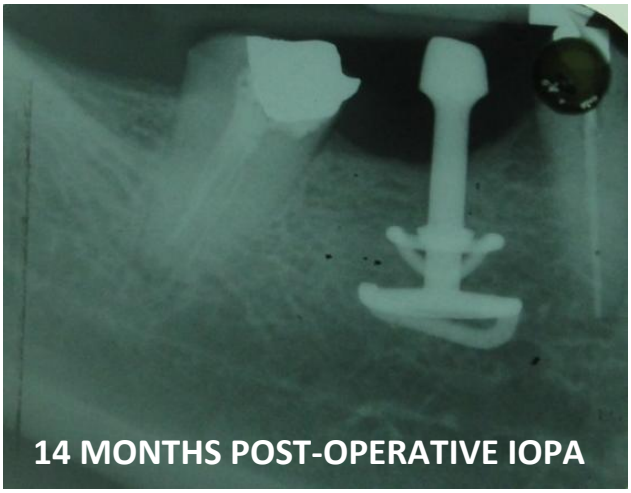


INSERTION COMPLETE



IMMEDIATE RESTORATION WITH ACRYLIC CROWN

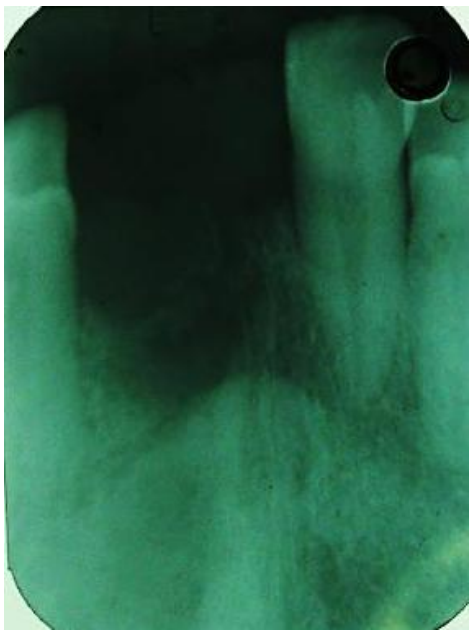
IMMEDIATE POST-OPERATIVE IOPA

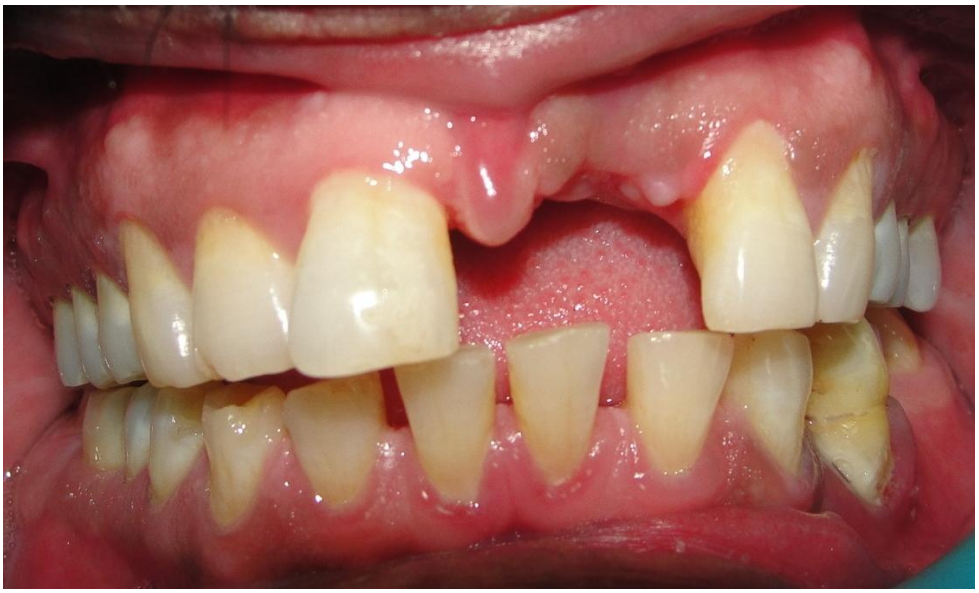


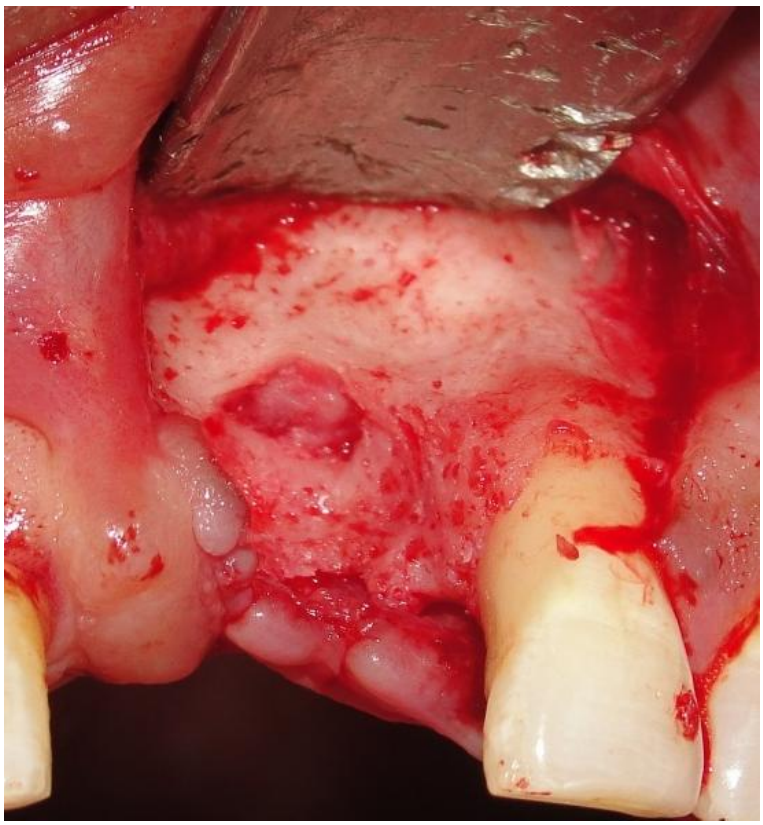
14 MONTHS POST-OPERATIVE IOPA

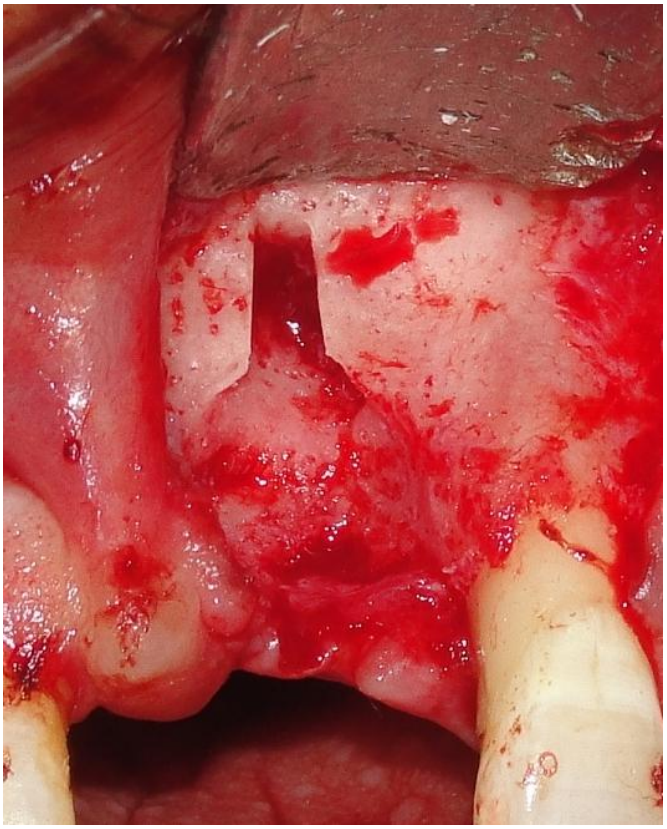
14 MONTHS POST-OPERATIVE PHOTOGRAPH WITH CERAMIC CROWN

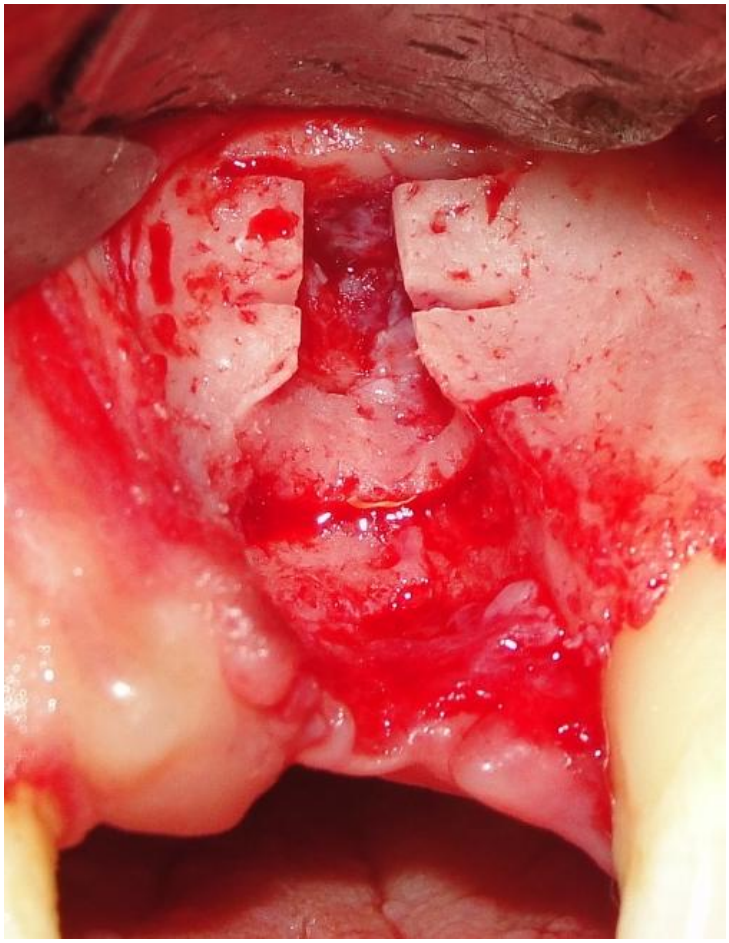
MAXILLARY ANTERIOR BOI IMPLANT PLACEMENT IN A CASE OF SEVERE BONE LOSS

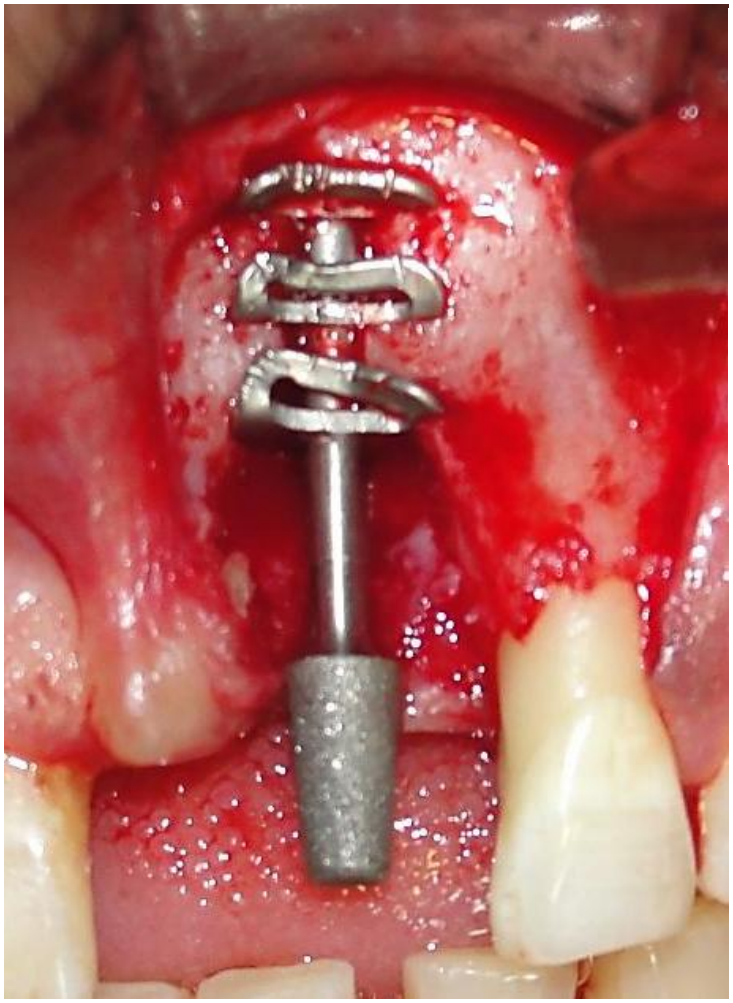


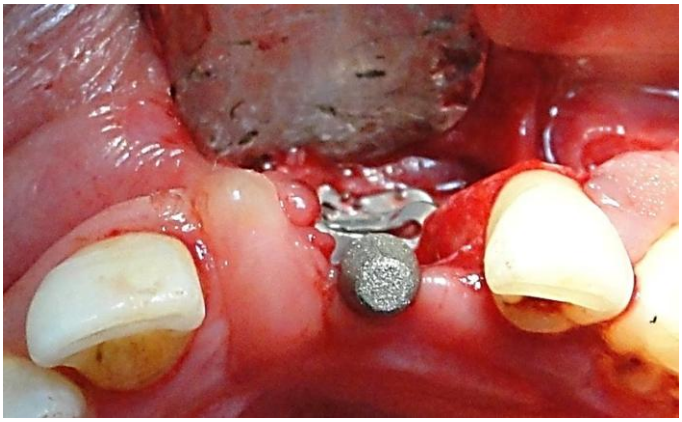


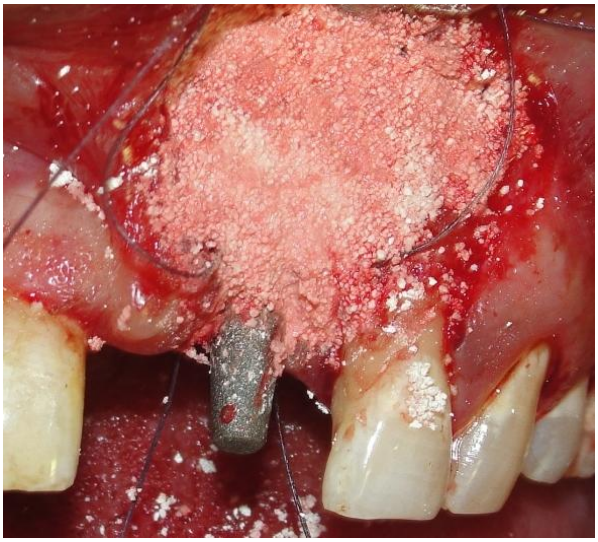


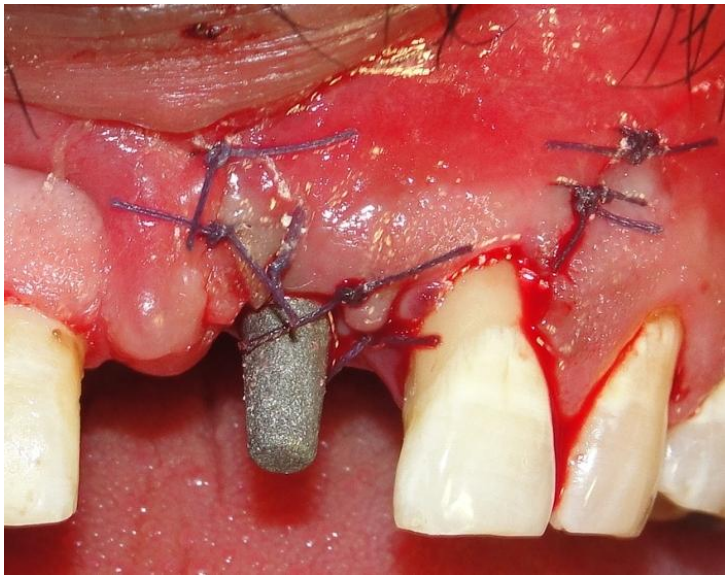


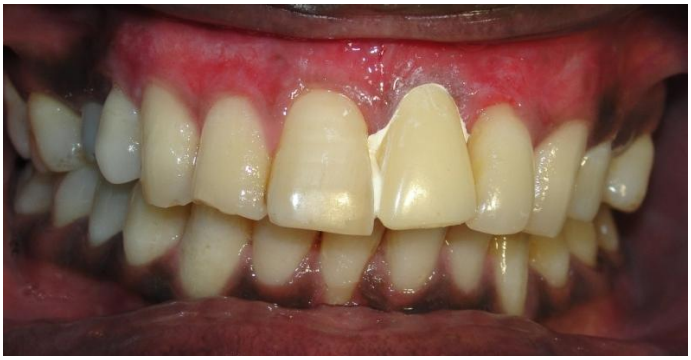


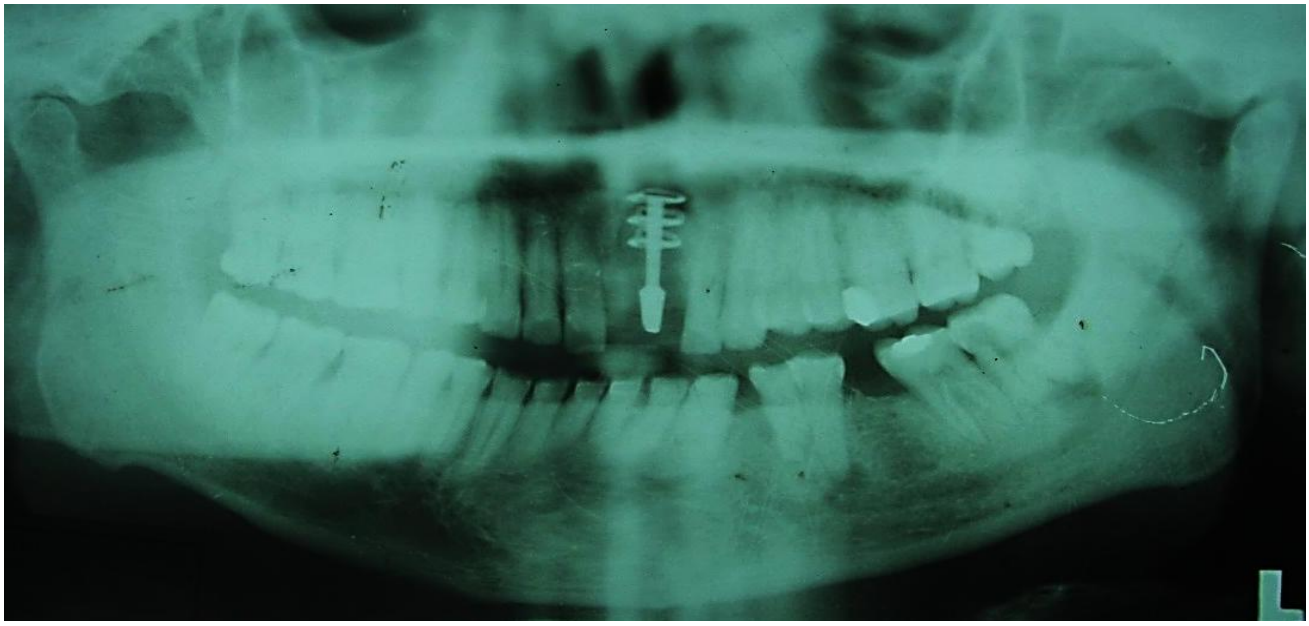


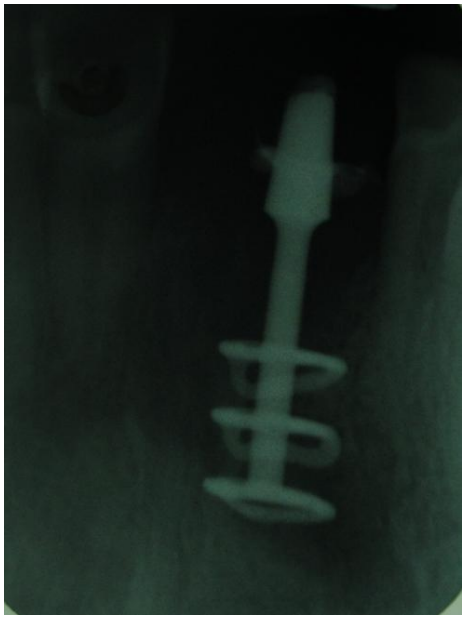












MATERIALS AND METHODS

Patients

In this clinical study, 11 patients presenting with one missing tooth satisfying the inclusion and exclusion criteria, reporting in the Department of Oral and Maxillofacial Surgery, Ragas Dental College and Hospital, Chennai from 2010-2011 were selected. Informed consent was taken prior to surgery and the source data was collected in a proforma.(Table 1)

Diagnostic protocol

A comprehensive diagnostic assessment was performed. Clinically, alginate impressions were taken to fabricate the diagnostic casts and these were articulated. Bone mapping of the edentulous site was performed under local anesthesia and the measurements were transferred to saggitally sectioned plaster models to estimate the bone width and form.

Radiographically, an OPG was taken after insertion of a template containing a metallic ball of a fixed diameter to eliminate the magnification error and estimate the available bone height at the edentulous site. Also, an IOPA radiograph of the edentulous site by using a standardised paralleling cone technique with a film holder and an aiming device was taken.

Surgical protocol

This implant was placed in the edentulous locations under local anaesthesia (2% lignocaine with 1:80,000 adrenaline), by local infiltration. After raising a full thickness flap, the implant bed was created through lateral access using vertical cutters, horizontal cutters and combination cutters. The first vertical bone cut was performed with tungsten carbide cutter to avoid unneccesary wear of the vertical

cutter. The preparation was performed using an high speed aerotor handpiece for the vertical cut and a reduction gear contra-angle handpiece at a speed of 3000rpm with copious irrigation. Next, the combination cutter was used to create the initial lateral cut and refine the vertical cut creating a path of insertion for the implant. This was followed by the lateral cutter which enlarged the lateral cut according to the implant size and type used. For double or triple disk BOI implant, an additional double-disk cutter was used to maintain the distance between the crestal and the basal disk. Subsequently the basal cut was widened according to the diameter of the basal disk. In case of triple disc BOI implant, the double disk cutter was used twice, with the cuts overlapping each other to create the third slot. The implant size and type (depending on number of disks as single disk, double disk and triple disk) were selected depending on the amount of bone available. More than one disk was preferred in cases with sufficient bone as it would provide better cortical anchorage and stability of the implant. Once the vertical and lateral bone cuts were created, the implant was inserted through a lateral access using carefully dosed hammer style strokes with a pencil osteotome and mallet. The rectangular side of the basal disk faces the vestibular aspect and the rounded side remained on the medial aspect. The presence of sufficient support was verified visually and manually by testing with fingers. Any part of the projecting disk was then bent and adapted to the bone surface. In cases where there was a bony defect left behind, the implant surface was covered on its buccal/labial side with particulate alloplastic graft followed by placement of a resorbable membrane. However this was done for esthetic areas only like the maxillary anterior region as primary stability was not a problem with these implants. Sterile Ringer's lactate was used as a cooling medium as it is said to be more benign than saline. Horizontal mattress sutures were placed for closure using 3-0 silk or 4-0

vicryl suture material in case of esthetic areas where simultaneous bone grafting was done.

Post-surgical protocol

All patients were administered with a single dose of steroid (Inj.Decdan 8mg) and analgesic (Inj.Voveran 75mg) intramuscularly, immediately after the procedure. They were also prescribed a regime of oral antibiotics (Cap.Amoxicillin 500mg, TDS; Tab. Metrogyl 400mg TDS), analgesics (Tab.Imol, BD) and H2 receptor antagonist (Tab. Rantac 150 mg, BD) for a period of 5 days. They were advised to perform ice-pack application extraorally over the surgical site for a period of 48 hours in an intermittent fashion. Then onwards, they were encouraged to perform warm saline mouth rinses daily. Suture removal was done for all patients on the 5^{th} post-operative day.

Restorative protocol

Impressions were made for provisional restoration immediately after insertion of the implant within 2-3 hours duration and the implants were provisionalised with a non-occluding prosthesis on the same day for most of the cases, with self cure crown and bridge acrylic material. Only, two patients were delivered the prosthesis the next day. The provisional crowns were cemented to the abutments with a temporary cement (EBA modified Zinc oxide Eugenol cement material) .

Three months later, the implants was definitively restored with fully occluding ceramometal restoration after thorough clinical and radiographic evaluation as mentioned in the follow-up protocol below.

All patients were instructed to avoid any occlusal loading over the implant immediately after placement and for a period of 3 months, after which they were

asked to subject the implant to moderate loading forces only, initially. A gradual increase in loading was advised, till the osseointegration period was complete (approximately one year).

Follow-up protocol

Clinical and radiographic data was collected at 1day, 1week, 3weeks, 1month, 3months, 6months and 12months follow-up appointments and the data collected was tabulated. Clinical evaluation was done by: manual pressure and percussion of the implant, status of peri-implant gingiva, status of adjacent and opposing teeth, oral hygiene.

Standardised radiographic assessments was done by: IOPA radiograph of the implant site using the standardised paralleling cone technique with a film holder and an aiming device, to rule out presence of implant mobility or peri-implant radiolucency. Peri-implant marginal bone levels were not recorded as performed in crestal implantology as there is no osseointegration expected in these regions in a BOI implant. Subject assessment and quality of life was measured at every follow-up visit.

INCLUSION CRITERIA

1)Missing single tooth (healed edentulous site or fresh extraction site).

2) Adequate or inadequate bone volume at the edentulous site. 2)

3) Minimum bone height of 2-3mm and minimum bone width of 5-7mm at the base of the edentulous site.

4)Smokers and non-smokers were included in this study.

5) Patients with and without periodontitis of any grade.

5)Skeletally mature and between 18-80 years age upon signing the informed consent form.

6)Willingness to participate in the duration of the study.

EXCLUSION CRITERIA

1)Chemotherapy

2)Immunosuppressive therapy.

3)Leucopenia

4)Malignant haemopoietic disease.

5)Uncontrolled systemic disease.

6)Uncontrolled diabetes.

7)Bisphosphonate therapy.

8)Current use of medication known to cause gingival enlargement, such as Cyclosporine A, Nifidipine, or Phenytoin.

9)Evidence of severe parafunctional habits like clenching and grinding.

10)History of localised irradiation treatments in or near the proposed implant sites.

11)Pregnancy or likelihood of pregnancy during the sudy.

12)Patients with uncritical and negligient attitude towards life.

CASE HISTORY PROFORMA

Serial no : Register no :

Name : Age/Sex:

Address:

Contact no :

e-mail:

Chief complaint :

MEDICAL HISTORY

Diabetes mellitus:

Hypertension:

Cardiac problems:

Blood dyscrasias:

Neural disorder:

Liver disorder:

Thyroid disorder:

HIV:

H/O jaw fractures or jaw lesions:

Exposure to radiation:

Chemotherapy:

DRUG HISTORY

Allergies:

Anticoagulant drugs:

Antibiotics:

Other medications:

PERSONAL HISTORY

Habits

Smoking: Duration:

Alcohol: Duration:

Betel nut chewing: Duration:

Brushing: Duration:

CLINICAL EXAMINATION

B.P:

Pulse:

Respiratory rate:

Temperature:

State of edentulosness

Partially edentulous-

Kennedey's Classification:

Missing tooth/teeth:

Skeletal Jaw Relationship:

PRE-TREATMENT EVALUATION

Midlines:

Deviations:

Pain:

Elongation of teeth:

Posterior teeth:

Anterior teeth:

Deviation of Occlusal plane:

Lateralisation of dentition:

Vertical dimension:

Unilateral extractions:

Condylar angle:

AFMP angle (Planas Masticatory Functional angle) :

Diastemas:

Non-correctable dysfunctions:

Mouth opening:

Nature of soft tissue:

Conditions of standing teeth:

Oral hygiene:

Alveolar ridge conditions:

Palpation of implant site:

Structural H/O implant site

Any previous implants in the implant site:

Reason for loss:

Any recent extractions in the implant site:

Speech and Hearing function

Position of teeth:

Spatial relationship of tongue and other soft tissues:

Pattern of chewing:

Deviation of mandible:

Other observations:

Study Models

Mesiodistal width:

Interocclusal gap:

Radiographic evaluation

Available bone height: Radiographic height of available bone x clinical diameter of metallic ball / radiographic diameter of metallic ball

Relation of anatomical structures:

Available bone height (if CT available)

Pre-treatment procedure

Bone Mapping:

Available bone width:

Other observations:

INVESTIGATIONS

a)Radiological: OPG/Frontal Ceph/Lateral Ceph/IOPAS/CT

b)Systemic: TC,DC,Hb%,ESR,BT,CT,RBS,HbsAg, HIV I,II

c)Special investigations if any:

TREATMENT PLAN

A)Total number of implants:

B)Site of implant:

Size of implant:

Type of implant:

C)Any other procedure:

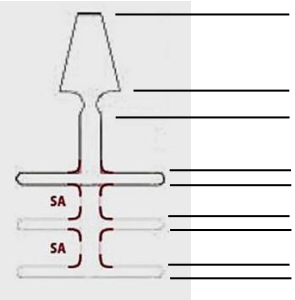
FOLLOW-UP

	1 day	1 wks	3 wks	6 wks	3 mon	6 mon	1yr
CLINICAL							
Plaque index							
Bone loss							
Mobility							
Condition of sorrounding tissues							
Condition of prosthesis							
Relationship of adjacent teeth							
Relationship of opposing teeth							
Pain/discomfort							
Paresthesia/numbness							
Aesthetics							
RADIOGRAPHIC							
Radiolucency							
Satus of Osseointegration							
PATIENT SATISFACTION							

Other problems:

DESCRIPTION OF BOI-IMPLANTS

NOMENCLATURE



IMPLANT HEAD: sandblasted head with standard height of 7.2mm and width of 3.5mm

SOFT TISSUE COLLAR: polished, having standard height of 1.8mm

SHAFT: polished, with standard diameter of 2mm and variable height (H) in mm

SA: Distance between disks available as 3mm unless specified as 'X' with distance of 5mm

SH 1-3: Disk height (individual disks). It is variable depending on type of implant

BS: Single disk BOI with antirotational cube shaped disk

Eg: BS 7: Disk diameter 7mm

DESCRIPTION	H	SH1	SH2	SH3	SA
BS 7	H 8	0.7-0.9			
BS 7	H 12	0.7-0.9			
BS 9	H 6	0.7-0.9			
BS 10	H 4	0.7-0.9			
BS 10	H 6	0.7-0.9			
BS 10	H 10	0.7-0.9			
BS 12	H 6	0.7-0.9			
BS 12	H 8	0.7-0.9			
BS 12	H 10	0.7-0.9			
BS 12	H 12	0.7-0.9			

BOI – BAST

Eg: BAST 10/16: average width of 10mm and length of 16mm

With cogs on flat side and may be rotated after placement

DESCRIPTION	H	SH1	SH2	SH3	GD
BAST 10/16	H 4	0.7-0.9			9.5
BAST 10/12	H 6	0.7-0.9			9.5
BAST 10/16	H 6	0.7-0.9			9.5
BAST 10/14	H 8	0.7-0.9			9.5
BAST 10/16	H 8	0.7-0.9			9.5

GD: maximum diameter on round side in mm

In red - Implant types used in this study

BOI - BAS 9/12 was used in two cases - currently not available

BOI – BBS

Eg: BBS 9/7: diameter of basal disk 9mm, diameter of crestal disk 7mm

DESCRIPTION	H	SH1	SH2	SH3	SA
BBS 7	H 6	0.7-0.9	0.7		3
BBS 9/7	H 6	0.7-0.9	0.7		3
BBS 9/7	H 10	0.7-0.9	0.7		3
BBS 9/7	H 8	0.7-0.9	0.7		3
BBS 10	H 4	0.7-0.9	0.7		3

BOI – BBBS

Eg: BBBS 7: diameter of all disks 7mm

DESCRIPTION	H	SH1	SH2	SH3	SA
BBBS 7	H 4	0.6	0.6	0.6	3
BBBS 7	H 6	0.6	0.6	0.6	3
BBBS 7	H 8	0.6	0.6	0.6	3

BOI - BAC

Used in severely atrophic areas, also can be used as a subperiosteal implant

BOI - DISKOS 4T

BOI implant with asymmetric disks for use in areas with reduced mesiodistal width

In red - Implant types used in this study

CUTTERS FOR BOI

VERTICAL CUTTER

Description	L	SH	SA	DV
VC 1.9	32			1.9
VC 1.6	32			1.6

COMBINATION CUTTER

Description	L	SH	SA	DV
KC 7-4W	32	0.4		7
KC 8-4W	32	0.4		8
KCD 7-4W	32	0.4	3	7
KCXD	32	0.6	5	9

LATERAL CUTTER - Single

Description	L	SH	SA	DV
LC 7-4W	32	0.4		7
LC 7-6W	32	0.6		7
LC 7-8W	32	0.8		7
LC 8-4W	32	0.4		8
LC 9-4W	32	0.4		9
LC 9-6W	32	0.6		9
LC 9-8W	32	0.8		9
LC 9-10W	32	1.0		9
LC 10-4W	32	0.4		10
LC 10-6W	32	0.6		10
LC 10-8W	32	0.8		10
LC 12-4W	32	0.4		12
LC 12-6W	32	0.6		12

LATERAL CUTTER - Double

Description	L	SH	SA	DV
LCD 7-4W	32	0.4	3	7

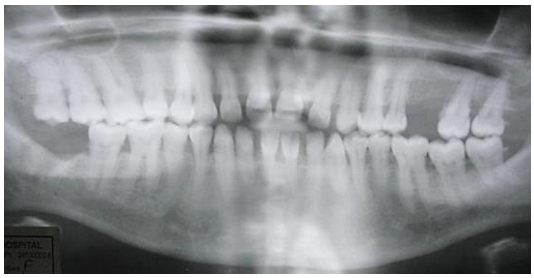
LATERAL CUTTER - Triple

Description	L	SH	SA	DV
LCT 7-4W	32	0.4	3	7

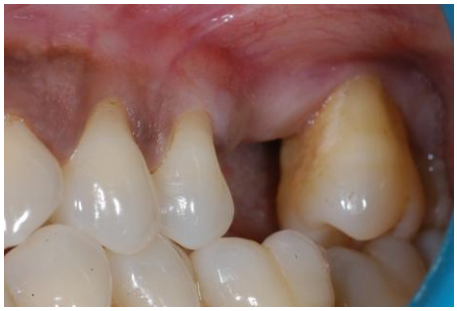
MAXILLARY POSTERIOR IMPLANT PLACEMENT

PRE – OPERATIVE PHOTOGRAPHS

OPG

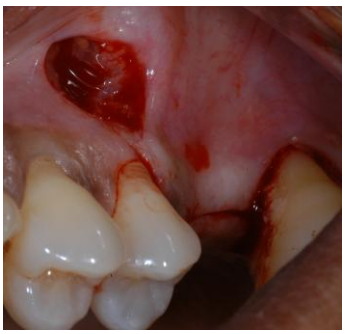


Photo

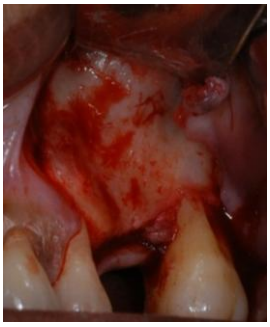


INTRA-OPERATIVE PHOTOS

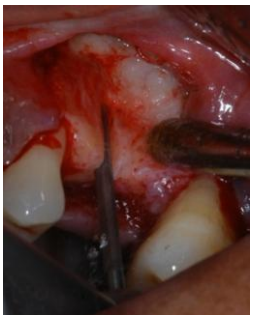
Incision



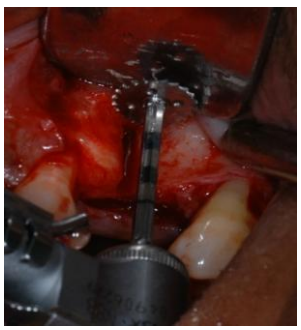
Exposure



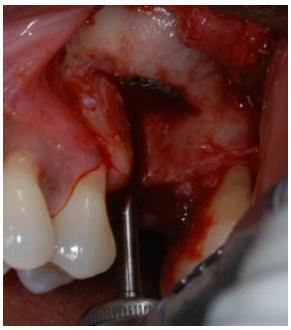
Vertical cut using VC 1.6



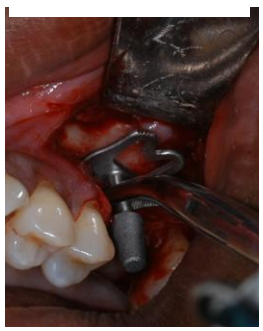
Combination cut - Vertical and Lateral using KC 7



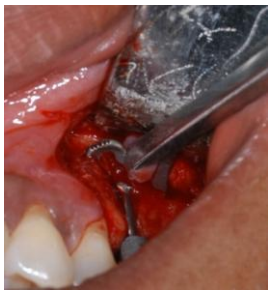
Lateral cut using LC 9-6W



BOI BAS 9/12,H6 placement

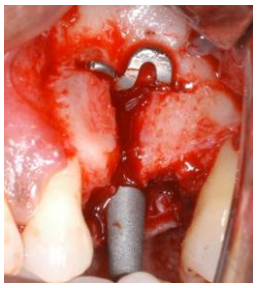


Insertion of the implant

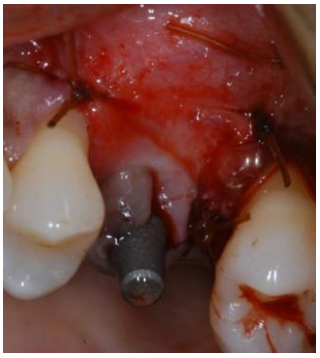


Bending of the protruding disc

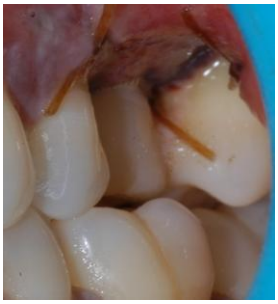
Implant insertion complete



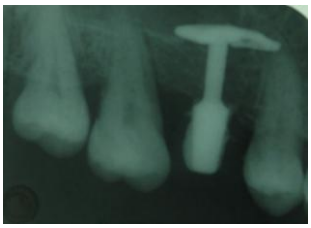
Closure



Immediate restoration with acrylic crown

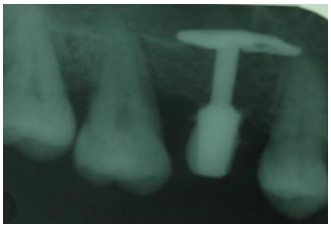


Immediate post-operative IOPA

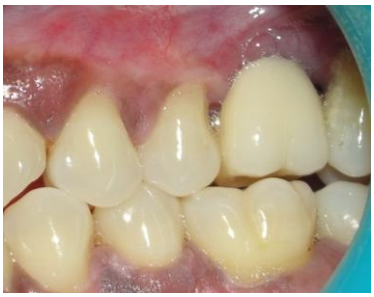


17 MONTHS POST-OPERATIVE PHOTOS

IOPA



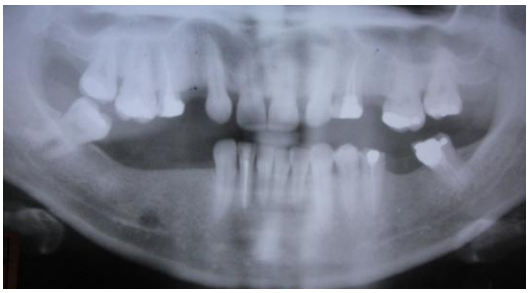
Clinical Photo with final ceramic restoration



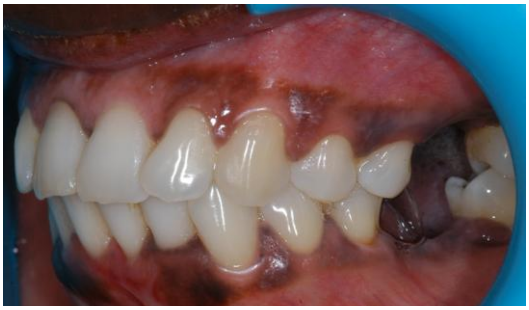
MANDIBULAR POSTERIOR BOI IMPLANT PLACEMENT

PRE – OPERATIVE PHOTOGRAPHS

OPG

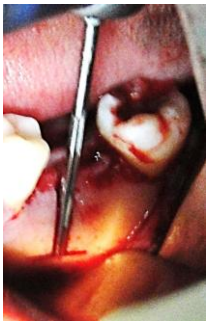


Photo



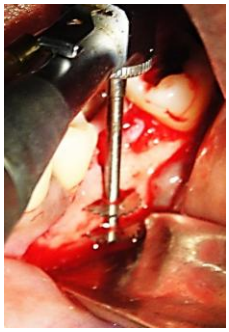
INTRA-OPERATIVE PHOTOGRAPHS

Vertical cut using
VC 1.6

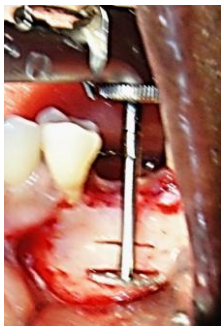


Vertical and lateral cut
(basal) using KC 7

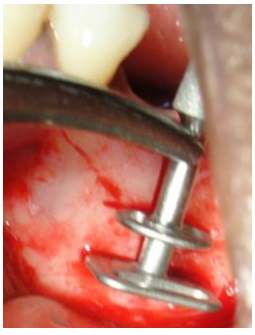
Double disk lateral
cut using LCD 7



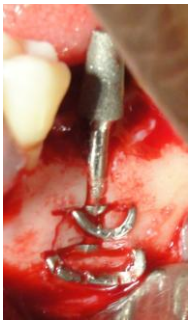
Lateral cut using LC 9-6W
for basal cut



Insertion of BOI
BBS 9/7,h6

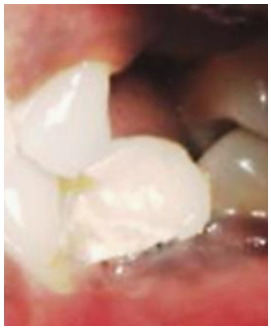


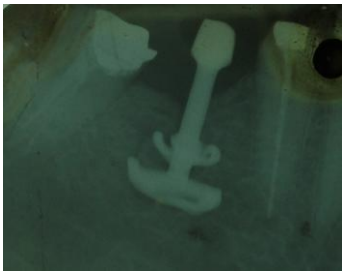
Implant insertion
complete



oration
with acrylic crown

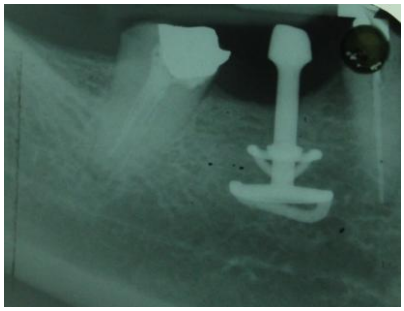
Immediate post-
operative IOPA



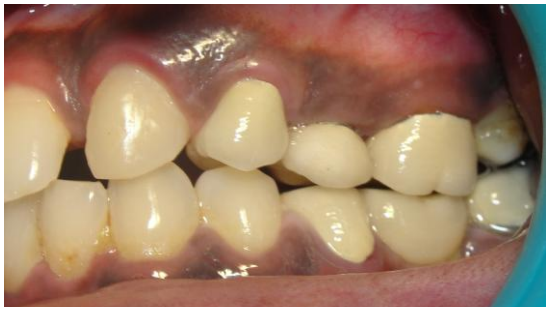


16 MONTHS POST-OPERATIVE PHOTOGRAPH

IOPA



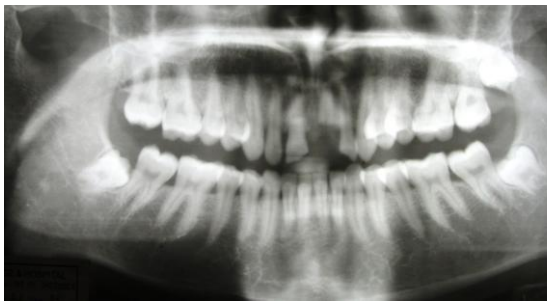
CLINICAL



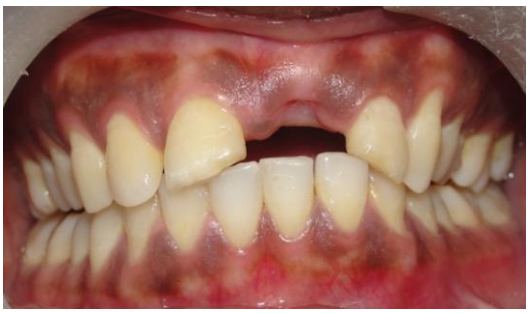
MAXILLARY ANTERIOR BOI IMPLANT PLACEMENT

PRE-OPERATIVE PHOTOGRAPHS

OPG

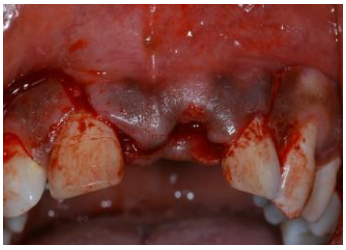


PRE-OPERATIVE PHOTOGRAPH

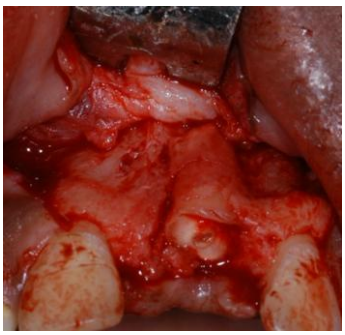


INTRA-OPERATIVE PHOTOGRAPHS

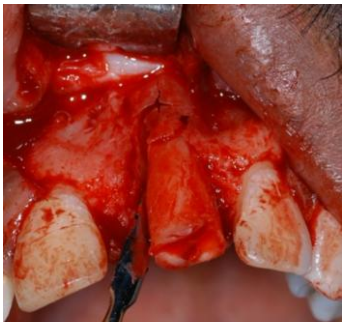
Incision



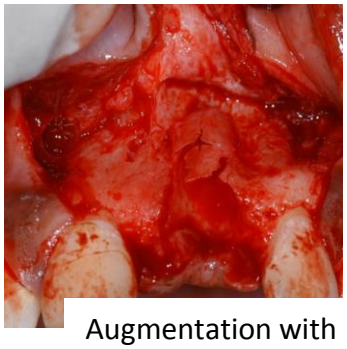
Exposure



Extraction of root stump

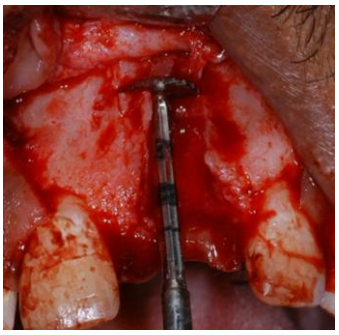


Loss of labial cortical plate



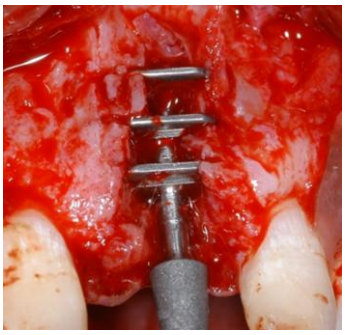
Augmentation with hydroxyapatite graft

Lateral cuts placed using KC7 and LCD 7

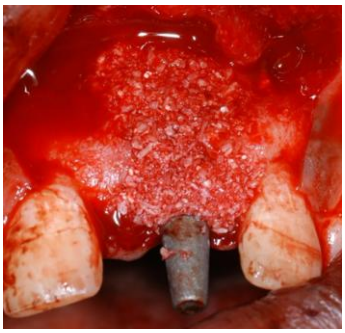


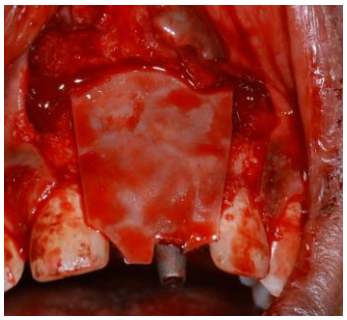
Defect covered with resorbable membrane

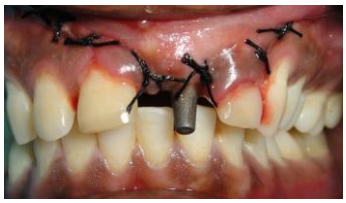
Insertion of BOI



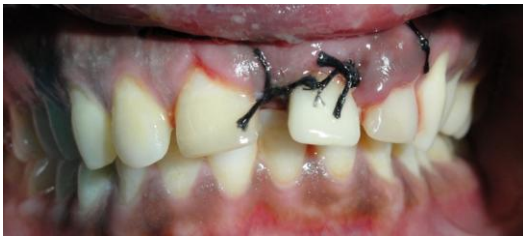
Closure



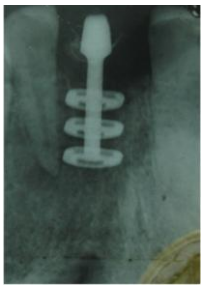




Immediate restoration with

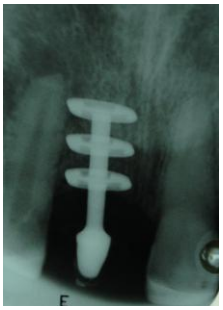


Immediate post-operative IOPA

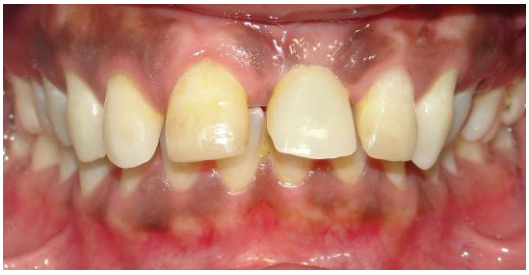


16 MONTHS POST-OPERATIVE PHOTOGRAPHS

IOPA



Restoration in place

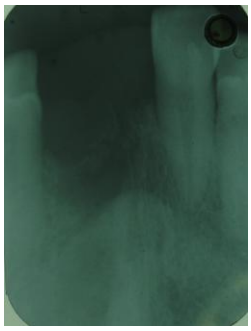


MAXILLARY ANTERIOR BOI IMPLANT PLACEMENT IN A CASE OF

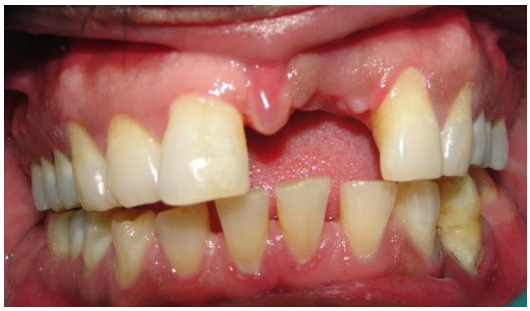
SEVERE BONE LOSS

PRE-OPERATIVE PHOTOGRAPHS

IOPA

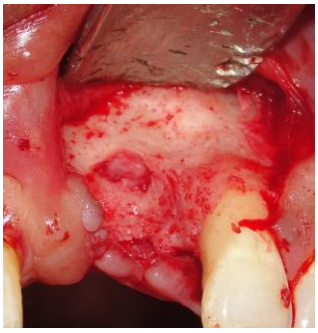


Clinical photograph

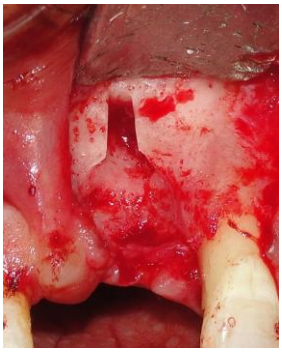


INTRA-OPERATIVE PHOTOGRAPHS

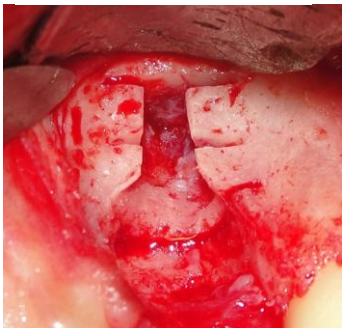
Exposure of the defect



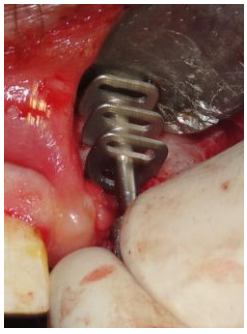
Vertical cut placed using VC 1.6



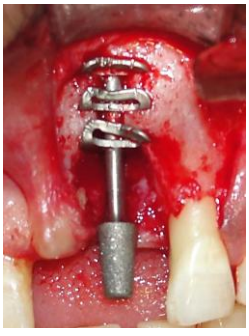
Lateral cuts placed using LCD 7



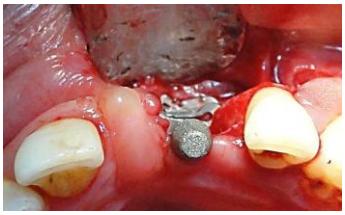
Insertion of BOI BBS 7, h6



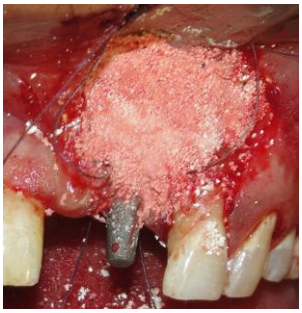
Insertion complete



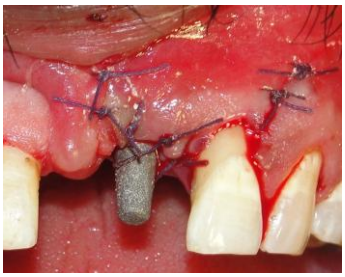
Labial contour



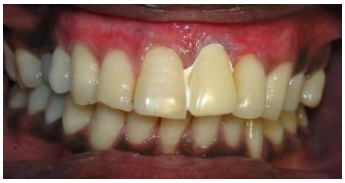
Augmentation with alloplastic bone graft



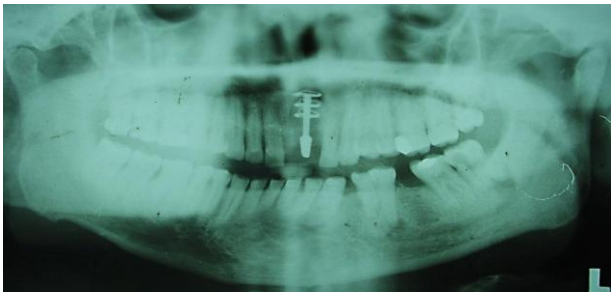
Closure



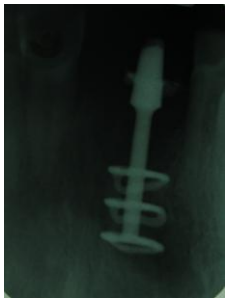
Immediate restoration with acrylic crown

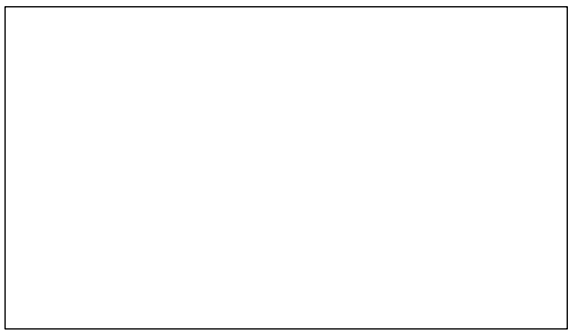


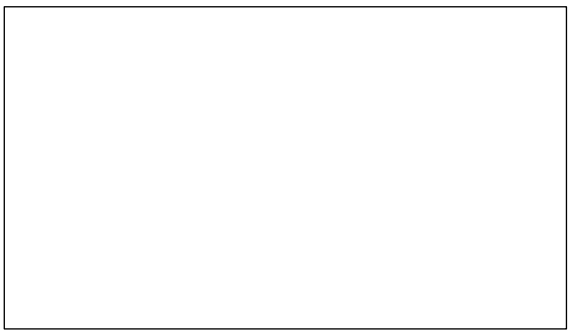
Immediate post-operative OPG

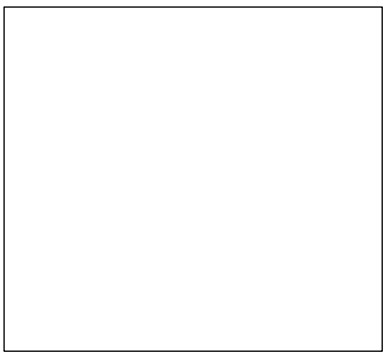


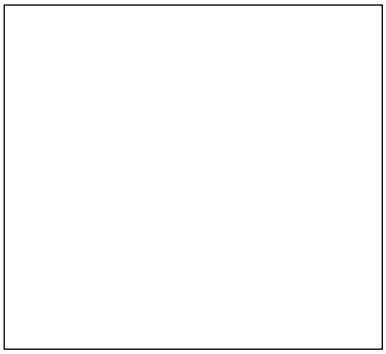
Immediate post-operative IOPA

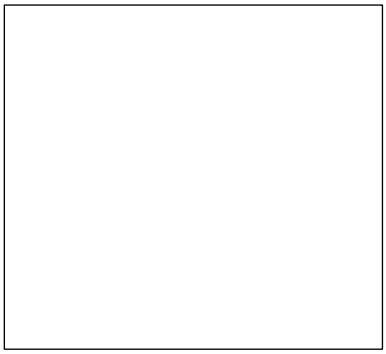


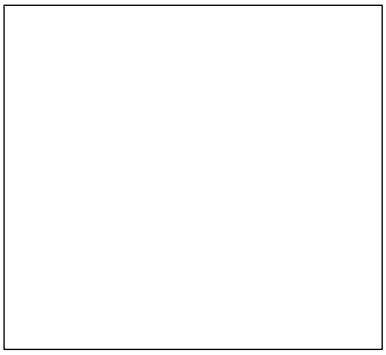












Eleven patients satisfying the inclusion and exclusion criteria were recruited according to the study protocol and provided written consent for it. Patients were followed for a mean of 9.54 months. None of the patients dropped out or disappeared for any reason in the series reported here.

Out of the 11 implants, 6 were placed in the maxilla and 5 in the mandible. In the maxilla, out of the 6 implants, 3 were placed in maxillary first molar region and three in maxillary central incisor region.

In the mandible, out of the 4 implants, 3 were placed in mandibular first molar region and one in mandibular second molar region. In the maxilla, 3 implants were placed in the sub-nasal position, 2 in the sub-antral position and 1 implant was placed trans-antrally.

9 implants were placed in healed bone, 1 in healing bone with granulation tissue where the tooth was lost 2 weeks before implant placement and 1 immediately after extraction.

Of all implants 3 were of single disks, 4 were of double disks and 3 were of triple disks.

A shaft height of 6mm was used in two implants and 4mm for one implant, placed in the maxillary first molar region. In the maxillary central incisor region, a shaft height of 4mm was used in 2 implants and 6mm in one implant, where the implant was placed just below the anterior nasal spine. A shaft height of 4mm was used for all the implants placed in the mandible.

Simultaneous augmentation with hydroxyapatite bone graft was done after placement of all three implants in maxillary central incisor region, only for achieving the lost labial contour.

All the patients were immediately restored with acrylic crowns within 3 hours post-operatively with only two implants were restored after 24 hours.

The loading time varied between patients due to their unavailability at certain times. 5 implants have been loaded and 4 implants are to be loaded in the near future.

Clinical mobility was absent in 9 of 11 BOI implants placed during the study period, with 3 patients having a follow-up of more than one year, 5 patients with a follow up of more than or equal to 3 months and in one patient with a follow-up of 1 month. There were 2 patients who presented with implant mobility, after a follow-up of more than 6 months. These implants were regarded as failures, but the cause was due to surgical and prosthodontic errors and not due to the implant design. Removal and immediate insertion of another BOI implant, is planned for these 2 patients showing implant mobility, in the near future.

No radiolucency was seen around any of the implants around the region of the disks. There was bone loss seen around the vertical shaft of the implants in most of the patients, but it is of insignificance, as there is no role for osseointegration around the vertical shaft in basal implantology.

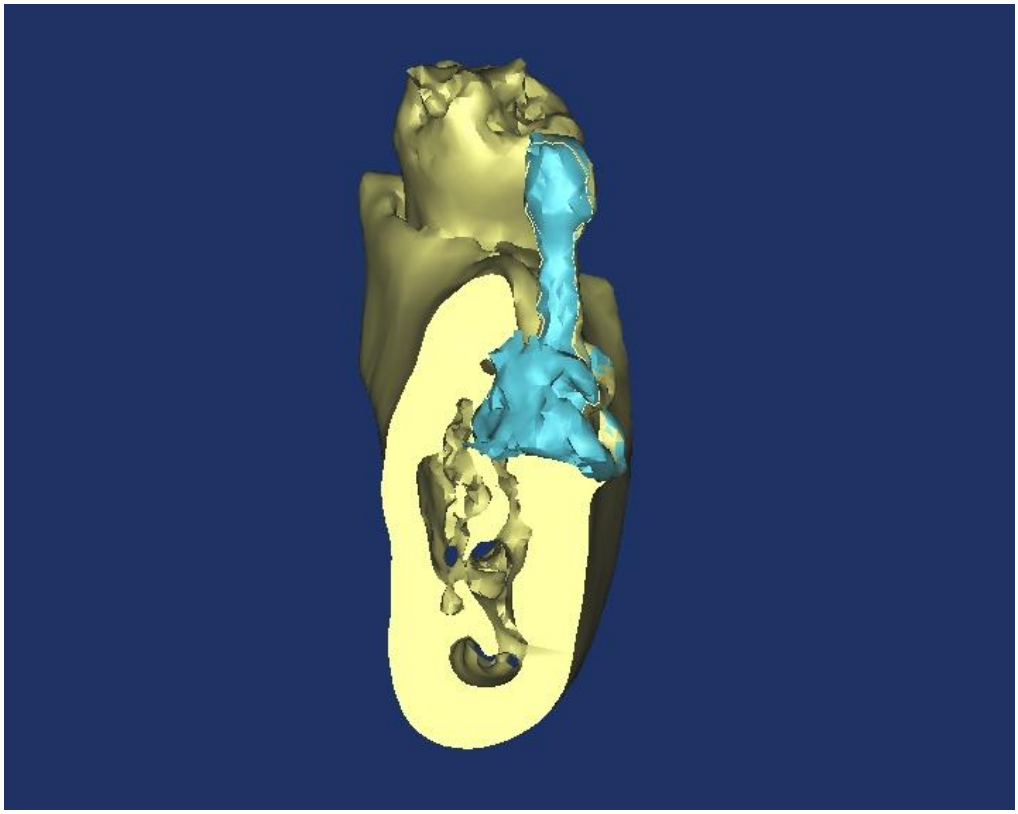
Also there were no signs of infection seen in any of the patients.

Direct sinus lift was avoided in two patients and autogenous block bone grafting in two patients, which would have been the procedure of choice prior to insertion of crestal implants. This saved around 12 months of time for these patients.

The overall patient satisfaction with the implant placement was good. Although three patients showed an average and one patient a poor satisfaction due to the implant failure and the surgical technique as such which involves tapping the implant in the osteotomy slot with an osteotome.

SL.NO	AGE/ SEX	TIME-IN SITU	JAW	MISSING TOOTH	LOCALIZAT -ION	BONE STATUS	IMPLANT DESIGN	SHAFT HEIGHT IN mm	SIMULTANEOUS BONE AUGMENTATION	RESTORATION TIME	LOADING TIME
1	41/F	17 months	MAXILLA	26	TRANS-ANTRAL	HEALED BONE	SINGLE DISK	6 mm	NO	3 Hours	12 Months
2	26/M	16 months	MAXILLA	21	SUB-NASAL	FRESH EXTRACTION SOCKET	TRIPLE DISK	4 mm	YES	24 Hours	-
3	39/F	17 months	MAXILLA	26	SUB-ANTRAL	HEALED BONE	SINGLE DISK	6 mm	NO	3 hours	12 Months
4	39/F	16 months	MANDIBLE	36	DISTAL LOWER JAW	HEALED BONE	DOUBLE DISK	4 mm	NO	24 Hours	3 Months
5	40/F	15 months	MANDIBLE	36	DISTAL LOWER JAW	HEALED BONE	DOUBLE DISK	4 mm	NO	4 Hours	-
6	35/M	8 months	MANDIBLE	46	DISTAL LOWER JAW	HEALED BONE	DOUBLE DISK	4 mm	NO	3 Hours	4 Months
7	37/F	4 months	MANDIBLE	47	DISTAL LOWER JAW	HEALED BONE	DOUBLE DISK	4 mm	NO	3 Hours	-
8	26/M	4 months	MAXILLA	21	SUB-NASAL	HEALED BONE	TRIPLE DISK	4 mm	YES	3 Hours	4 Months
9	26/M	4 months	MANDIBLE	46	DISTAL LOWER JAW	HEALED BONE	DOUBLE DISK	4 mm	NO	3 Hours	-
10	43/M	3 months	MAXILLA	21	SUB-NASAL	HEALING SOCKET	TRIPLE DISK	6 mm	YES	3 Hours	-
11	41/F	1 months	MAXILLA	26	SUB-ANTRAL	HEALED BONE	SINGLE DISK	4 mm	NO	3 Hours	-

SL.NO	MOBILITY	RADIOLUCENCY AROUND DISKS	ADDITIONAL SURGICAL PROCEDURE AVOIDED	AVERAGE TIME SAVED DUE TO USE OF BOI IMPLANT	PATIENT SATISFACTION
1	ABSENT	ABSENT	DIRECT SINUS LIFT	12 MONTHS	GOOD
2	PRESENT	ABSENT	AUTOGENOUS BONE GRAFTING	12 MONTHS	AVERAGE
3	ABSENT	ABSENT	-	-	AVERAGE
4	ABSENT	ABSENT	-	-	GOOD
5	ABSENT	ABSENT	-	-	POOR
6	PRESENT	ABSENT	-	-	GOOD
7	ABSENT	ABSENT	-	-	GOOD
8	ABSENT	ABSENT	-	12 MONTHS	GOOD
9	ABSENT	ABSENT	-	-	GOOD
10	ABSENT	ABSENT	AUTOGENOUS BONE GRAFTING	12 MONTHS	GOOD
11	ABSENT	ABSENT	DIRECT SINUS LIFT	12 MONTHS	GOOD



3D RECONSTRUCTED VIEW SHOWING FAILURE OF BOI IMPLANT IN POSTERIOR MANDIBLE DUE TO UNICORTICAL ANCHORAGE

Basal osseointegrated implants, offer a attractive alternative , even in small bone volumes, to conventional root-form implant placement, which often requires bone grafting [2].

Substantial implantological results can only be obtained if implants incorporated into the functional complex of the skull do not affect the functional morphological changes of the jawbone[27]. Preferably they should be placed in areas where the bone is safe from resorption, so that enough volume will be available for many years to come. These safe regions include not only the mandibular anterior segment but other areas as well. BOI implant is a good alternative to crestal implants when additional procedures are indicated like in the region above the mandibular nerve, below the maxillary sinus, into extraction sockets of teeth, cavities and empty spaces left after cystectomies or granulation removals. After all lost bone structures will rebuild by themselves wherever functional loads induce them to rebuild or for that matter where the dentist indigenously directs them.

The literature on basal implants had introduced the terms ‘orthopaedic technique’ and ‘orthopaedic implant’ to mark a clear distinction between them and the well known term ‘dental implant’. They can be applied where very little vertical bone is present, while the supply of horizontal bone is still sufficient, even if these quantities are not contiguous such as in the sinus region. There are no difficult or impossible cases for implantologists familiar

with basal implants, and their use leads in all cases straight forward to the desired treatment result[19].

Osseointegration with basal implants

During the insertion of basal implants, vertical and horizontal slots have to be prepared. The subsequent repair within the bone requires a complete remodelling of atleast the horizontal part of the mandible. These transosseous slots may be considered to be four semi fractures. Their repair leads to full remodeling of atleast the crestal horizontal part of mandible and this remodeling is accompanied with overall softening of bone[7].

During early healing, the primary means of anchorage for the implant is through retention of the base plate in the basal, cortical jaw bone area, which in turn may be further secured by small screws to help fix the implant under immediate masticatory loads [13].

The typical healing progression which follows is the the transformation of a blood clot to fibrous tissue, which later mineralizes and becomes woven bone. This woven bone may provide additional stabilization to the implant, although it continues to be remodeled over time into an even more supportive secondary osteonal bone, the end result of healing process[13].

These implants never experience Branemark style load transmission or osseointegration taking place along the vertical shaft of these designs.

An adequate blood supply is decisive for long term survival of BOI implants, which specifically applies to area of crestal disk as well. The BOI implants featuring larger disk to disk intervals of 5mm have found both basal plates integrated evenly well.

The formation of secondary osteons around one of the base plate does not seem to interfere with similar formations on the other basal plate. Also, the nutrient supply for each basal plate is assumed to be larger if the disks are located further apart. Problems with implant restoration systems supported by this type of implants are extremely rare.

Histologic proof of osseointegration of immediately loaded, laterally inserted disk type of implants was first obtained in 1985 when Juliet T3D titanium implant was removed from a patient prior to therapeutic irradiation.

Cortical bone has a very broad spectrum of functional adaptive mineralisations. Bicortical engagement of the base plate is mandatory in any case. Unicortically anchored disk implants has a high value of equivalent stress[8]. If double BOI implants are chosen, both base plates must be positioned below the white line[15]. The stress values are 15% lower in double disk implants than in single disk ones[10].

The stress is significantly lower during the complete osseointegration stage than during the stage when the implant is not integrated into the bone, that is after implant placement. Stress decreases by 10.1% in a stage of non-

osseointegration, 28.8% in a stage between non-osseointegration and complete osseointegration, 58.4% when cortical bone grows into the implant body[11].

The maximum stress concentration is at the disc/shaft interface of the implant[3].

With the physiological stimulus by basal implants on present bone, remodeling leads to new vital bone in areas of load transmission[17].

The bone remodeling after surgery is in normal physiologic grade after about 1 year, so the influence of the factor of interest in this study is clearly distinguishable in this actual observation period.

Basal implants versus crestal implants

Survival rates for conventional dental implant systems are relatively high in normal healthy bone[16]. The management of poor bone with root form dental implants typically requires additional or augmentation procedures to ensure stability.

Disease, congenital anodontia, trauma or atrophy to the aging process leads to poor quality and quantity of bone[16]. Short implants are an alternative and yield acceptable results, as long as at least 5mm of vertical bone is available. However these implants cannot be used in immediate load procedures and due

to their two-stage design the demand for attached gingiva in the mucosal penetration area and the demand for meticulous cleaning limits its use[14].

In addition traditional bullet shaped screw designs are not a option for treating such cases as these feature an internal screw connection, these require not only bone height, but also bone width. Their surface is roughened and the mucosal penetration diameter is large. To prevent infections and bone loss, attached gingiva should surround the implant. Even if this is given, the effort for successful (professional and individual) cleaning is large because the sites are difficult to reach in cases of pronounced atrophy[14]. With basal implants degradation products of infection are resorbed via the periosteal tissues or removed to the oral cavity through the mucosal access. The necessary pressure is built from inside the bone. This pressure must never be blocked, and the direction of flow must never be inverted by the dentist. Early idiopathic loss thus hardly ever occurs with basal implants[19].

The very small demand for available bone qualifies BOI to be good for minimally invasive and fast treatment. Surface enhanced crestal implants are susceptible to peri-implantitis, which may lead to progressive ridge resorption. This is not present in basal implants because usually the disease stops as it reaches basal (resorption resistant) bone areas[19]. Also because of the narrow polished emergence of the implants and in addition the site of bacterial invasion is far away from site of force transmission, the bone is not burdened with two tasks at the same time. Moreover, the implant areas where the load

transmission takes place are integrated in such a way that the osteogenic and osteoprotective properties of the cortical bone are utilized[27].

Scortecci et al. (2001) showed that 99% of the patients not eligible for treatment with screw implants can be treated by BOI without bone transplantation.

The vertical aspect of the cylindrical crestal implant must be placed in close contact to the alveolar bone for primary stability, a basal implant due to the nature of the insertion process, shows little or no contact in this area for some time[13].

Due to large support of the base plates, the dentist and the technician is allowed to take freedom in positioning of the masticatory surfaces, other than conventional implants, which are supported only by the bone near the vertical part of implant itself, and supporting polygon is reduced. Basal implants provide a wide and deep supporting polygon that provides good support to the prosthesis[15].

BOI in special situations

Vertical bone split procedures are useful if enough vertical bone is present pre - operatively, to insert at least short types of conventional implants.

Horizontal bone split procedures (distractions, bone interpositions) may also be used in order to increase bone volume. In cases of failure, the mobile crestal segment of the bone gets lost. Such patients can receive implants with an incomplete bi-cortical horizontal osteotomy allowing the insertion of the basal implant and immediate completion of the case without further necessity of increasing the bone volume, transporting bone, a second stage surgery, etc[14].

With basal implants, augmentatioin and reopening is avoided, have immediate function and are generally implanted simultaneously with extraction[16]. There has been a success rate of 98.1% for basal implants in fresh extraction sockets even after 4.5 years[22].

Patients who have been treated successfully with implants in the past will likely select implants in lieu of prosthesis in the event of an implant failure. Use of BOI implants in such patients can avoid the long waiting periods associated with other modes of restoring the normal masticatory function[9]. Also when conventional dental implant systems fail, there is typically little bone for immediate re-implantation. For BOI implants, almost any amount of bone remaining is sufficient for corrective procedures in most cases. This coupled with the patient benefit of immediate functional use makes BOI an excellent alternative for treating patient with failed dental implants[9].

Basal implants are not known to show crater-like bone defects, possibly due polished vertical implant surface area[13].

If the patient suffers from osteoporosis, basal implants may be placed in the manner of subperiosteal implants. Implants with length of 33 and 43 mm are available. The diameter of the central base plate is 9mm[14].

Smokers and non-smokers experience similar rate of implant losses. This may indicate that smokers, reported as having a higher risk of implant loss than the conventional implants may benefit from BOI implant treatment[16]. It is however, recommended that, patients should not smoke for atleast 6 weeks before and 3 weeks after the procedure[27].

Periodontal diseases are generally considered to be a contraindication for implantologists even if revitalized. The presence of germs and a history of ineffective treatments give a difficult prognosis for crestal implants[18]. The advantage of basal implants is the dysjunction of the infection risk area of gum perforation and the load transmitting areas in the aseptic deep basal cortical bone. Even in cases where BOI's are immediately inserted into the infected alveoli, the healing can't be disturbed by infection and functional load[18]. The first reason are the horizontal osteotomy cuts in the deepest area where a wound drain is not hindered as typical with screw type implants, sealing bone hermitically. Second, the geometry of BOI is infection preventive. The thin, smooth vertical shaft (diameter < 2mm), is not directly load transmitting to the crestal bone. So plaque and calculus adherence is rare and far away from force fit implant interaction. Mucositis linked with BOI is reported rarely (<1%).

Design and selection of basal implants

The only statistically significant factor on success is the implant design. Studies have shown that, survival rate in multiple disk implants (96.6%), is 1.7% higher than those with single disk (94.9%)[16].

In BOI systems, the fate of the alveolar ridge is not linked to the fate of the implant-restoration complex, since the areas where load transmission takes place are spatially separated from masticatory surfaces. This fact is obvious from the design of BOI implants[27].

The crestal and basal plates of the multi-disk BOI inplant restoration systems have different functions. The main purpose of the crestal plate is to provide additional stabilization of the implant. The crestal plate looses its importance once the basal plate has ossified to full load bearing capacity. The web-bar of the crestal plate is located perpendicular to the web bars of the basal plate. In other words, this part of the crestal plate is inserted directly into the palatal bone well protected against resorption.

The osteotomy area in the vestibular bone is crossed only by the ring of the crestal plate. The ring acts like a tent keeping the periosteum away from the bone, thus facilitating any primary or secondary augmentation procedures.

Multiple disk implants are used in higher but narrow bone (canine eminence, anterior alveolar ridge) single disk implants when vertical bone loss is extreme

(sinus region, above the mandibular canal), so leverage differences are obvious[16].

Double or multiple disk implants have been available in France since around 1988. The disk to disk interval on these implants is 3mm. specific double cutters matching these distances for lateral osteotomy are available. Also implants and osteotomy tools for 5mm disk to disk intervals are also available.

The rectangular design of the disks are flattened on one side and remain rounded on the other side. The rectangular side faces the vestibular aspect and the rounded side remained on the medial aspect. This led to the main burden of load shifted to the vestibular bone. Some users have modified this and inserted the other way where the main burden of load transmission is shifted to the medial bone structure as the vestibular bone structure is charecterised by extreme resorption.

The diameter of the basal disk in BOI implants should be as large as possible to meet prosthetic requirements. From the BOI implantologists view point, implants featuring a load-transmitting basal plate of less than 9mm in diameter (particularly those with a thickness of 0.6mm or more) must be regarded as rigid implants with a larger disk diameter are more elastic than with a smaller diameter disk of same thickness. The load transmitting surfaces of these implants are located farther away from potential infection entry points. This after all is the ultimate criterion for long term survival of the implants.

The distance between the load transmitting surfaces and the site of bacterial attack can be increased by using a large-diameter disk. An alternative option would be to select an implant with a longer shaft.

The web bars connect the disk of the vertical shaft. The shape and size of these bars depends on their function of converting functional loads to isoelastic vibrations and cyclic loads that the supporting bone can tolerate.

The bars should be resilient to fracture and capable of force distribution over larger bone areas to avoid osteolysis by local stress concentrations.

An equilibrated masticatory pattern is of particular importance for maintaining mineralization in the interfacial region, especially in the first months after implant placement[19]. Only when bilaterally identical AFMP (Planas' Masticatory Functional Angle) is present, the chewing activity of the patient will be equal on both sides. Often too long vestibular cusps in the upper jaw are the reason for non-identical angles[18].

Masticatory forces transmitted via the basal implants to an enossal location create local microcracks in the cortical bone as described before. Microcracks are replaced by the formation of secondary osteons, a process called remodeling. This however, will temporarily increase the porosity of the affected bone region and temporarily reduce the degree of mineralization additionally. Basal implants in this status have a good chance of getting

reintegrated at a high degree of mineralization, if loads are reduced to a adequate amount[19].

BOI in posterior maxilla

Maxillary sinus elevation and bone augmentation are acceptable techniques that may provide sufficient bone quantity and quality for implant support in the posterior atrophic maxilla. Yet given the morbidity risk plus cost and time consuming effects, these techniques are to be reconsidered. Simpler and safer protocols are therefore required for the posterior maxilla where bone resorption, deficient posterior alveolar ridge and increased pneumatisation of the sinus, all result in a minimal hard tissue bed thus rendering implant placement difficult[1].

The conditions in the maxilla regarding the relationship between internal pressure and external (that is cortical) compressive/tensile stresses are not the same as in mandible. In these cases, greater number of disks per implant should be selected. Also combination with several crestal implants may be desirable to ensure adequate stability of the structure.

Single base plate implants may be placed under the sinus in as little as 3mm vertical bone height, utilizing stable cortical anchoring. We have observed an good primary stability for placement and immediate restoration with BOI implant sub-antrally and also trans-antrally.

A larger number of implants or disks per BOI implant is necessary if the width of the occlusal surface of the prosthesis is desired to be larger and provide cusps.

The BOI implants have a smooth shaft, without causing any noticeable irritation for bacterial inoculation. Also it makes the implant restoration complex more elastic. This structural detail prepared the ground for comprehensive implant therapy along the maxillary sinus, by placing the disk and the shaft inside the sinus.

BOI in posterior mandible

For placing basal implants crestally to the nerve in the posterior mandible, approximately 2-3mm of vertical bone above the alveolar nerve are necessary and the morphology of the bone must allow the insertion of a bicortically anchored base plate and cover it as much as possible[14]. The base plates of these implants is generally 0.7mm high and at the top of the base plate another 1-2 mm of native bone should be available[14]. However careful placement and advanced experience are required as there is anectodal evidence that some of the attached complications to using basal implants can be fracture of implant, iatrogenic mandibular fracture and advanced nerve sensation[14].

The atrophic bone in distal jaws is frequently broad, which is an ideal condition for basal implants due to their lateral placement[16].

Posterior implants in mandible are usually square shaped having a disc of 9x12mm, 9x16mm, 10x14mm with shafts of 6-13.5mm in length, depending on the desired vertical dimension and available horizontal bone. The thickness of the base plate itself is 0.6-0.9 mm, this allows implant to participate in the flexion of the mandible and provides safe ground for fixed prosthesis[15].

Failure to place the distal BOI implant below the white line will result in loss of bone (due to overload osteolysis, often combined with an infection) and subsequently in the loss of the implant[15].

Also, placement of BOI in posterior mandible was found to be more technically demanding due to the thick nature of the cortical bone which does not give way to minor adjustments as possible in the porous bone of the maxilla.

BOI in aesthetic zone

When teeth in aesthetic zone are scheduled for extraction and replacement by implants, this poses a combination of challenges. First it is often difficult to anchor conventional implants because the buccopalatal and the mesiodistal dimensions of the tooth roots are greater than the dimensions of the implants. Further, we have experienced cases with loss of labial cortical plate in the central incisor region. In such cases cases, the use of a multi-disk BOI implant with the most basal disk inserted into the thick cortical bone below the anterior

nasal spine is a good option. In addition intense bone remodeling and soft tissue recontouring occur, which make it difficult to achieve a lasting aesthetic result quickly. A combination of a single-stage surgical approach with a two-stage prosthetic approach is one option to solve this problem[6]. Augmentation may still be necessary in aesthetic zones. The vestibular struts of BOI implants may project out of the bone and support the augmentation material. In this technique, augmentation may be performed simultaneously with implant placements. The decrease in total treatment time may reach upto 98% [24].

DO'S and DONT'S with BOI

Examining the status of the peri-implant bone is considered malpractice with basal implants, as no osseointegration is required on the vertical aspect of the implant anyway for permanent function of the implant[19].

Probing may carry pathogens to the depth of the interfacial region that is filled with non-irritant connective tissue at a time when there is little chance of suppuration left. Callus formation and the maturation of the callus in the slot areas are endangered through probing. Facultative pathogens can be transported to a environment that is normally inaccessible to them and cause great damage. In particular, the maxillary sinus area may be contaminated by germs of oral origin by simple probing, if bone height is reduced or if a trans-

sinus insertion was performed. Probing around basal implants is therefore contraindicated and is potentially dangerous[19].

Anterior patterns of chewing are to be avoided. These patterns lead to an extrusion of implants in the posterior segments and at the same time the bone area around the implants are subject to tensile forces, which reduce the mineralization significantly[15].

When approaching from the vestibular side, the facial artery and its vein must be protected meticulously with the help of a broad spatula or a instrument in the shape of a soup spoon[14].

Reasons for failure of the implants are poor oral hygiene, poor bone quality, compromised medical status of the patient and biomechanical factors. Various authors have stressed the importance of biomechanical factors such as type of loading, the bone implant interface, the length and diameter of implants, shape and charecteristics of implant surface, the prosthesis type and the quantity and again the quality of surrounding bone[3].

Implant displacement within the bone depends simply on the degree of osseointegration[10].

Osseointegration at a lowered degree of mineralization is not the same as “fibrointegration”. Orthopaedic surgeons describe the equivalent status of orthopaedic implants as “sterile loosening”, but they have no means of treating the status. Basal implants in this status have good chance of getting

reintegrated at a high degree of mineralization, if loads are reduced to a adequate amount[19]. For sterile loosening of basal implants, numerous therapeutic options exist; functional adjustment or combined surgical/functional treatment of bone/implant/restoration systems are required and in some cases the reduction of muscle forces is part of the therapy plan. Such options are not given for crestal implants. Even the replacement or addition of basal implants is easily possible, since there is usually sufficient cortical bone available for additive therapy[19].

If an indication for replacing basal implant really exists, this measure should be taken right away, since mobile implants will invariably cause bone damage. By contrast with screw type implants, BOI implants will never exfoliate spontaneously. For this reason and because overload trauma may be transferred from one side of the jaw to the other via the denture or via a involuntary change in the preferred working side, there is no point waiting. The objective of any replacement will be to restore the full function of the fixed restoration and thereby the full range of masticatory movements. This is why the insertion of the new implant must be planned along with the removal of old implant. In most cases immediate reimplantation will be possible and indicated. Problems must be addressed immediately and professionally not least in order to prevent the spread of overload related damage to other implants, which carries a risk of subsequent fracture and overload osteolysis and thus to prevent bone loss. It is not necessary to wait with corrective

intervention, because every patient has enough bone for treatment with basal implants[19].

Survival data of BOI

Basal implants used for single tooth replacement showed the lowest survival rate (90.9%) by Kopp, but this was result of specific overload due to non-physiologic, uncompensated forces[23].

The better survival rates in implants longer in situ comes from their survival of initial threats as possible infections, malocclusions and surgical and prosthodontics mistakes[16].

Donsimoni et al. reported a 97% survival rate and a 100% clinical success rate. Similar results have been reported by Scortecci, Kopp, Ihde and Mutter and Ihde. However this was with the use of basal osseointegrated implants which were always splinted with other implants (basal or crestal implants) or with natural teeth.

The quality of life, was ultimately evaluated by the ability to chew all range of foods native to the diet, to speak legibly, socially acceptable smile and dentofacial profile and comfortable without halitosis and pain.

This study shows a good success rate in use of these implants for single tooth replacements, however a larger group of patients need to be evaluated to generalize the data.

The standard procedure for placing basal implants includes one surgery followed by immediately loading, thus reducing time, cost and stress to the patient. With the emphasis on horizontal rather than vertical placement, pre-implantological bone augmentation was never required for anchorage.

Primary stability is never a problem with basal osseointegrated implants because of the implant design and bicortical nature of anchorage. This offers several advantages like - no hospitalization required, no time period with loss of esthetics and a missing tooth, low degree of invasiveness, no second surgery, no bone transplants, no bone distractions, simple repair in difficult areas, manageable system (few components), simple lab technique.

However, stock keeping requirements are greater than in basal implantology. It will always be necessary to keep a few more implants handy to avoid extensive planning including three dimensional exploration of bone conditions.

Also, the technique poses substantial challenges for instructors and users alike, as far as the surgical and prosthetic treatment stages and substantial knowledge requirements in the field of biomechanics and bone physiology are concerned.

Although we had two implants failures, one due to unicortical anchorage and the other due to occlusal overload during the osseointegration period, it does

not effect the final outcome of this study as these were mainly due to operator errors.

Basal implants have always shown to perform well in immediate load conditions, when splinted with other implants or natural teeth. But when they are subjected to a loading protocol which is gradual and not immediate, it does not seem to affect the osseointegraton, in single tooth edentulous sites. Immediate restoration in such cases would not significantly increase the load over the implant during this period. Mild contacts during mastication though unavoidable, acts like a stimulation for bone remodeling to take place.

We have observed a good success rate in this study, during a observation period of maximum 17 months from our earliest cases. Although, a larger sample size is required to generalize this data.

All cases reached and maintained the treatment aim of immediate restoration and early occlusal loading. This indicates that, placement of basal osseointegrated implants in single edentulous sites is a predictable and reliable procedure and is a good option to be considered in compromised situations to avoid additional procedures like bone grafting and sinus lifts.

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