ASSESSMENT OF THE SUCCESS OF SHORT IMPLANTS: A CLINICAL STUDY

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In

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By

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LIST OF ABBREVIATIONS

SLA	Sandblasted and acid etching
mPI	Modified plaque index
mGI	Modified gingival index
BOP	Bleeding on probing
RCTs	Randomized controlled trials
RFA	Resonance frequency analysis
ISQ	Implant Stability quotient
DAE	Dual acid-etched
CSR	Cumulative survival rate
CAD/CAM	Computer aided design / Computer aided manufacturing
CIR	Crown-to-implant ratio
SDI	Short dental implants
MBL	Marginal Bone Loss
BIC	Bone-implant contact
PPD	Probing pocket depth
RVG	Radiovisiography
XCP	Extension cone paralleling
PFM	Porcelain fused to metal
IAN	Inferior alveolar nerve
CBCT	Cone-beam computed tomography
IOPARs	Intraoral periapical radiographs
OPGs	Orthopantomograms

The most common cause of tooth loss is Periodontitis and other causes include dental caries, trauma, developmental defects and genetic disorders. Long implants have always been considered more desirable in this respect but in patients with advanced alveolar bone resorption their placement is problematic due to the anatomic boundaries. The use of short or nonstandard-diameter implants could be one way to overcome this limitation. Short implants can be used in the posterior maxilla in order to avoid complementary surgical procedures. Short implants maybe a simpler, cheaper and faster alternative to long implants placed in augmented bone and with less associated morbidity, if they can be shown to have similar success rates. The patients were selected on the basis of the inclusion and exclusion criteria. The study design selected was naïve direct comparison in which only the concerned treatment (i.e., placement of _ultra-short implants‘) was done and the results of present study were compared to previous data from a well known systematic review by Lemos et al 2016. A total of 10 ultra short implants were placed in the posterior edentulous sites with alveolar ridge of width equal to or more than 6 mm. The marginal bone loss (MBL) was evaluated at different time intervals up to 1 year. The modified Plaque Index (mPI), modified Gingival Index (mGI) and Probing Pocket Depth (PPD) were measured up to 1 year at different time interval. The results of this study showed that Short dental implants can be used to support single unit restorations in lower jaws. There was no significant difference between short implants and conventional implants with regard to survival rates of implants, marginal bone loss, complications, and prosthesis failures. Hence, it can be concluded that placement of ultra short implants can be a cost-effective treatment option having similar result to that of conventional implants.

INTRODUCTION

The most common cause of tooth loss is Periodontitis, other causes include dental caries, trauma, developmental defects and genetic disorders. In the last 30 years the use of dental implants to rehabilitate the loss of teeth has increased to a great extent.[1] Implants have made important contribution to dentistry as they have revolutionized the way by which missing teeth are replaced with a high success rate. This success of an implant depends on the ability of the implant material to integrate with the surrounding tissue. Factors such as implant material, bone quality and quantity and the implant loading condition influences this integration.[2] The predictability of several endosseous oral implant designs has increased to a great extent in recent decades. Dental implants have become a very popular solution due to the high success rate and predictability of the procedure, as well as its relatively few complications. Various methods such as machining, plasma spray coating, grit blasting, acid etching, sandblasted and acid etching (SLA), anodizing, and biomimetic coating has been used to increase the surface roughness of implants.[1] For dental implants to succeed, intimate contact between the peri-implant bone and the implant surface should be achieved and maintained. Therefore, integration between the implant surface and the bone is required for the success of any implant system. This integration is known as osseointegration, which is defined as a direct structural and functional connection between ordered living bone and the surface of a load-carrying implant.[2] Longer and wider implants were used for many years for successful outcomes, on the basis that these implants provide greater surface area for bone contact which in turn increases implants‘ anchorage and enhances their long-term survival. In addition, longer implants were thought to distribute the occlusal loads more efficiently since they would provide a favorable implant to crown ratio.[4] In an atrophic alveolar ridge, there are many anatomical limitations (maxillary sinus, nasal floor, nasopalatine canal, inferior alveolar canal) that make placement of a standard implant difficult. To overcome these limitations and vertical bone deficits, additional surgical procedures, such as guided bone regeneration, block bone grafting, maxillary sinus lift, distraction osteogenesis, and nerve repositioning are performed to place a standard implant. However, the procedure is sensitive, challenging, costly, and time-consuming and increases surgical morbidity and many complications such as sinusitis, infection, hemorrhage, nerve injury, and gait disturbance can occur[1]. In resorbed ridge cases short implants offer a less invasive treatment alternative [5]. The term of a

short dental implant is subjective, and there is no clear criteria for the length of a short dental implant. Some articles defined 10 mm or less as the criterion of a short dental implant and some defined less than 10 mm as a short dental implant[1].Short implants can be used in almost all types of replacements whether fixed or removable including single and multiple fixed prosthesis in posterior jaw[6]. Grant et al evaluated the overall success rate of short implants (8 mm in length) placed in the partially or completely edentulous mandible and restored with fixed or removable prostheses. A total of 124 patients were included in the study, with placement of 335 short implants, and the survival rate obtained was 99% in the mandible. It was concluded that short implants provide a predictable treatment alternative to bone grafting and nerve lateralization for the atrophic mandible[7]. The main advantage of using short and ultra short implants is that it simplifies the implant surgery by avoiding the more invasive procedures like bone grafting, sinus lifting, nerve repositioning, etc., and thus decreases morbidity and reduces the healing period. There will be reduction of radiation exposure as advanced imaging modalities may not be required[8]. Patient acceptance will be more as it avoids the need for complicated surgeries, reduces the duration of treatment period and cost. In short implants, bone grafting to compensate for less height is unnecessary. Osteotomy preparation is simplified since shorter bone preparation is required at the implant site which provides direct access for water irrigation and reduces the possibility of bone overheating. Insertion of implant is easier. Angulation to load is improved with short osteotomy site since the basal bone beyond the original alveolar ridge is not always located in the long axis of the missing tooth[6]. There is paucity of literature stating the success of short implants therefore this study has been undertaken to further evaluate and establish the success of short implants.

AIM AND OBJECTIVES

AIM:

To assess the success of ultra short implants at different time interval

OBJECTIVES:

i. To measure the Marginal Bone Loss (MBL) at different time interval up to 1 year.

ii. To measure the Implant mobility at different time interval up to 1 year.

iii. To measure the modified Plaque Index (mPI), modified Gingival Index (mGI) and Probing Pocket Depth (PPD) at different time interval up to 1 year.

iv. To compare and discuss the result with pre existing data of conventional implants.

REVIEW OF LITERATURE

C M ten Bruggenkate et al, 1998[9] conducted a multicenter study of short ITI implants. In a 6-year period 253 short implants with a length of 6 mm were placed into 126 patients, who were followed up from 1 to 7 years. The quality of survival was comparable with the clinical results of longer implants from the same implant system. Although the clinical results of these short implants were favorable, they concluded that they be used in combination with longer implants, especially when used in the less dense bone that is often seen in the maxilla.

Akca K et al, 2002[10] conducted a study to evaluate the effect of additional placement of a shorter implant in place of a cantilever extension on stress distribution compared with cantilevered fixed prosthesis in mandibular posterior edentulism. An oblique occlusal load of 400 N was applied. Significant lower stress values were recorded at the shorter implant placement configurations compared with the cantilevered prosthesis. They concluded that in clinical applications where cantilevered fixed partial prosthesis seems to be inevitable because of anatomical restrictions and/or complications such as loss of implant, an additional placement of a shorter implant should be considered.

Hagi D et al, 2004[11] conducted a study to assess the relationship between dental implant failure rates and their surface geometry, length, and location (maxilla versus mandible). Twelve papers were identified as follows: eight with machined threaded implants, two with acid-treated threaded implants, and two with sintered porous-surfaced press-fit implants. Dental implant surface geometry is a major determinant in how well these implants perform in short lengths, defined here as lengths of < or = 7 mm. They concluded that while threaded implants show higher failure rates in short versus longer lengths, sintered porous-surfaced implants perform well in the defined "short" lengths.

Feldman S et al, 2004[12] conducted an analysis of prospective multicenter clinical studies evaluating the risk for failure of short-length implants, comparing dual acid-etched (DAE) Osseotite implants to machined-surfaced implants. The implant data included 2294 implants for the DAE series and 2597 implants for the machined-surfaced series. Cumulative survival rates (CSRs) were calculated with the Kaplan-

Meier estimator. In this analysis the difference in CSRs between short- and standard-length implants was greater for machined-surfaced implants than for DAE implants.

Renouard F et al, 2005[3] conducted a retrospective study to assess the survival rates of 6 to 8.5 mm-long implants in the severely resorbed maxilla following a surgical protocol for optimized initial implant stability. The study included 85 patients with 96 short (6–8.5 mm) implants supporting single-tooth and partial reconstructions. The cumulative survival rate was 94.6%. The authors concluded that the use of short implants maybe considered for prosthetic rehabilitation of the severely resorbed maxilla as an alternative to more complicated surgical techniques.

Misch CE et al, 2005[13] analysed a review which reveals implants shorter than 10 mm often have a higher failure rate than longer implants. These complications may be related to an increase in crown height, higher bite forces in the posterior regions, and less bone density. The authors concluded that the forces to the implants may be reduced by eliminating lateral contacts in mandibular excursions and eliminating cantilevers on the prosthesis. The area of forces applied to the prosthesis may be increased by increasing the implant number, increasing the implant diameter, increasing the implant design surface area, and splinting the implants together. As a result of these biomechanical methods to decrease stress, Misch, et al reported a 99% implant survival with 7-mm and 9-mm implants in the posterior regions of the jaws.

Neves F D et al, 2006[14] The purpose of this study was to consider the therapeutic decision whether to use advanced surgery or short implants based on data concerning the use of these implants found in follow-up studies. The analysis revealed that among the risk factors, poor bone quality in association with short implants seemed to be relevant to failure. The use of implants 4 mm in diameter appeared to minimize failure in these situations. They concluded that short implants should be considered as an alternative to advanced bone augmentation surgeries, since surgeries can involve higher morbidity, require extended clinical periods, and involve higher costs to the patient.

Misch CE et al, 2006[15] The authors conducted a study to evaluate implant survival when a biomechanical approach was used to decrease stress to the bone-implant interface. A biomechanical approach to decrease stress to the posterior implants

included splinting implants together with no cantilever load, restoring the patient with a mutually protected or canine guidance occlusion, and selecting an implant designed to increase bone-implant contact surface area. The authors concluded that short-length implants may predictably be used to support fixed restorations in the posterior partial edentulism. Methods to decrease biomechanical stress to the bone-implant interface appear appropriate for this treatment.

Morand M et al, 2007[16] conducted a study in order to assess the challenge of implant therapy in the posterior maxilla. An extensive review of the literature that is available for short implants (implants < 10 mm in length) indicates that although they are commonly used in areas of the mouth under increased stress (posterior region), their success rates mimic those of longer implants when careful case selection criteria have been used. The authors concluded that the available studies and case-series offer a valid rationale for placement of short implants so long as one understands the limitations, indications, risk factors, and limited studies that actually follow-up success rates of short implants for over 5 years.

Malo P et al, 2007[17] conducted a study to report on the placement of short Brånemark implants, to test the hypothesis that short implants in atrophied jaws might give similar long-term implant survival rates as longer implants used in larger bone volumes. The cumulative survival rates of 96.2% and 97.1% at 5 years for implants of 7.0- and 8.5-mm length, respectively. The authors concluded that one-stage short Brånemark implants used in both jaws is a viable concept.

Anitua E et al, 2008[18] conducted a study to evaluate the long-term survival rates of short dental implants in posterior areas and to analyze the influence of different factors on implant. Two of 532 implants were lost during the observation period. The overall survival rates of short implants were 99.2% and 98.7% for the implant- and subject-based analyses, respectively. The authors concluded that treatment with short implants can be considered safe and predictable if used under strict clinical protocols.

Grant BN et al, 2009[7] conducted a study to determine the overall success of short dental implants (8 mm in length) placed in the partially or completely edentulous posterior mandible restored with fixed and removable prostheses. Of the 335 implants placed, 331 integrated successfully. In the 2 cases that failed, the sites were grafted

with porous hydroxyapatite and platelet-rich plasma. The survival rate for 8-mm implants placed in the mandible was 99% from stage I surgery to a functional prosthesis for up to 2 years.

Raviv E et al, 2010[19] conducted a study to assess the literature on the use of short implants, discussed the biomechanical considerations when utilizing short implants. The treatment modality to replace the missing teeth with an implant-retained fixed partial denture includes sinus bone grafting in the maxilla and onlay bone graft in the mandible are invasive and requires more time and cost. The authors concluded that short dental implants can be used as an alternative treatment modality to bone grafting procedures.

Romeo E et al, 2010[20] conducted a study to evaluate the differences in survival rate and the rational use of short implants. Some of the parameters the clinician should consider are: 1) area to rehabilitate as well as bone quality; 2) length of the implant; 3) implant diameter; 4) type of implant and surface treatment; 5) crown to implant ratio of the final prostheses; 6) type of prostheses; 7) connection to other implants; 8) occlusal/ parafunctional load; 9) prosthetic complications. The authors concluded that it can be assumed that a careful treatment planning can lead the clinician to obtain a successful rehabilitation.

Sun HL et al, 2011[21] conducted a study to evaluate the long-term failure rates of short dental implants (</ 10 mm) and to analyze the influence of various factors on implant failure. The total failure rate was 4.5%. There was a tendency toward higher failure rates for the maxilla and for dental implants with a machined surface compared with the mandible and dental implants with a rough surface, respectively. The authors concluded that most failures of short implants can be attributed to poor bone quality in the maxilla and a machined surface.

Telleman G et al 2011[22] conducted a systematic review of the prognosis of short (<10 mm) dental implants placed in the partially edentulous patient. A total of 2611 short implants (lengths 5-9.5 mm) were analysed. An increase in implant length was associated with an increase in implant survival (from 93.1% to 98.6%). The authors concluded that short (<10 mm) implants can be placed successfully in the partially edentulous patient, although with a tendency towards an increasing survival rate per

implant length, and the prognosis may be better in the mandible of non smoking patients**.**

Annibali S et al 2012[23] conducted a review to systematically evaluate clinical studies of implants < 10 mm in length and to determine the success of short implant-supported prosthesis success in the atrophic jaw. The observational period was 3.2 ± yrs. The cumulative survival rate (CSR) was 99.1%.

The authors concluded that the provision of short implant-supported prostheses in patients with atrophic alveolar ridges appears to be a successful treatment option in the short term; however, more scientific evidence is needed for the long term.

Atieh MA et al 2012[24] conducted a study to systematically review studies concerning dental implants of ≤ 8.5 mm placed in the posterior maxilla and/or mandible to support fixed restorations. English-language articles published between 1992 and May 2011 were identified electronically and by hand search of the PubMed, Embase, and Cochrane libraries. The initial survival rate for short implants for posterior partial edentulism is high and not related to implant surface, design, or width. The authors concluded that short implants may constitute a viable alternative to longer implants, which may often require additional augmentation procedures.

Karthikeyan I et al, 2012[25] conducted a study to systematically evaluate the publications concerning short dental implants (< 7 mm) placed in the maxilla or in the mandible between 1991 and 2011. The survival rate of short implants was found to be increased from 80% to 90% gradually, with recent articles showing 100%. They concluded that short implants could be a preferable choice as the treatment becomes faster and cheaper and these are associated with less morbidity than vertical bone augmentation.

Mijiritsky E et al, 2013[26] conducted a retrospective cohort study to evaluate the influence of implant length and diameter on implant survival during the first two years of function. It was found that the survival rates for narrow, regular and wide diameter implants were 98.2%, 98.75% and 98.5% respectively. Survival rates of short and regular implants were 97% and 98.7% They concluded that implant length and diameter were not found to be significant factors affecting implant survival during the first two years of function.

Lai HC et al 2013[27] conducted a study to evaluate the long-term clinical and radiographic outcomes of short implants supporting single crowns in the posterior regions. High survival rates for both the implants and the prostheses could be achieved after 5-10 years for short implants supporting single crowns, without severe marginal bone loss and complications. The authors concluded that a single crown supported by a short implant is a predictable treatment modality. However, short implants in type IV bone sites should be applied with caution.

Hasan I et al 2013[28] conducted a study to review the studies published about short dental implants that investigated the effect of biting forces of the rate of marginal bone resorption around short implants and their survival rates. The clinical outcomes of 6 mm short implants after 2 years showed a survival rate of 94% to 95% and lower survival rate (<80%) for 7 mm short implants after 3 to 6 years for single crown restorations. The authors concluded that short implants can be considered as a good alternative implant therapy to support single crown or partial fixed restorations.

Monje A et al, 2013[29] conducted a study to compare the survival rate of short (<10mm) and standard (≥10mm) rough surface dental implants under functional loading. The peak failure rate of short dental implants was found to occur between 4 and 6 years of function whereas the peak failure rate of standard implants was between 6 and 8 years of function. They concluded that in the long term implants of <10 mm are as predictable as longer implants but they fail at an earlier stage compared to standard implants.

Al-Hashedi A et al 2014[4] conducted a study to evaluate the effectiveness and clinical outcomes of using short implants as a valid treatment option in the rehabilitation of edentulous atrophic alveolar ridges. Articles were included if they provided detailed data on implant length, reported survival rates, mentioned measures for implant failure, were in the English language, involved human subjects, and researched implants inserted in healed atrophic ridges with a follow-up period of at least 1 year after implant-prosthesis loading. The authors concluded that short implants demonstrated a high rate of success in the replacement of missing teeth in especially atrophic alveolar ridges.

Shetty S et al 2014[8] conducted a study to assess the effectiveness of short implants in rehabilitation of atrophic maxilla and mandible. Short implants are considered as a viable alternative in patients with reduced alveolar bone height to avoid more invasive procedures. They concluded that various methods to increase the functional surface area and decrease the stress on the prosthesis have greatly contributed to the success rate of short implants.

Nisand et al 2014[30] conducted a review to evaluate the available data on short length implants and discuss their indications and limitations in daily clinical practice. Thirty-two case series devoted to short-length implants, 14 reviews and 3 randomized controlled trials were identified. The authors concluded that short-length implants can be successfully used to support single and multiple fixed reconstructions in posterior atrophied jaws, even in those with increased crown-to-implant ratios.

Srinivasan M et al, 2014[31] conducted a review to test the hypothesis that 6mm micro rough short Straumann implants provide predictable survival rates and also to verify that most failures occurring are early failures. Studies were included that involved Straumann 6mm implants placed in the human jaws, which provided data on the survival rate, which mentioned the time of failure and which reported a minimum follow up period of 12 months following placement. They concluded that micro rough 6mm short dental implants are a predictable treatment option providing favorable survival rates.

Thoma DS et al 2015[32] conducted a study to compare short implants in the posterior maxilla to longer implants placed after or simultaneously with sinus floor elevation procedures. Based on the pooled analyses of longer follow-ups (5 studies, 16-18 months), the survival rate of longer implants amounted to 99.5% and for shorter implants to 99.0% The authors concluded that given the higher number of biological complications, increased morbidity, costs and surgical time of longer dental implants in the augmented sinus, shorter dental implants may represent the preferred treatment alternative.

Taschieri S et al 2015[33] conducted a study to evaluate clinical survival and success of partial rehabilitation supported by reduced-length implants in maxilla and mandible. Data from 53 short implants placed in 41 patients were presented. The authors concluded that shortimplants may be considered effective in supporting partial rehabilitation in bothmaxilla and mandible.

Demiralp K et al 2015[34] conducted a study to investigate the cumulative survival rates of Bicon short implants (<8 mm) with locking tapers and plateau root shapes, over a 5-year period. Data were evaluated to acquire cumulative survival rates according to gender, age, tobacco use, surgical procedure, bone quality, and restoration type. The authors concluded that short implants with locking tapers and plateau-type roots have comparable survival rates as other types of dental implants.

Schincaglia GP et al, 2015[35] conducted a study to test whether the use of short dental implants (6 mm) results in similar clinical and radiographic outcomes compared to long implants (11-15 mm) in combination with sinus grafting. Patients with partial edentulism in the posterior maxilla, with a residual bone height of 5-7 mm and ridge width of ≥ 6 mm were considered for the study. It was found that both treatment options for the posterior atrophied maxilla were successful. They concluded that short implants (6mm) provided a similar clinical and radiographic performance compared to longer implants (11-15mm) placed in combination with a sinus augmentation procedure.

Ting M et al, 2015[36] conducted a review to study the implant survival of the wide diameter implant and to analyze if the length, the implant surface or the placement location has any effect on its survival. They found that the location, length and surface of the wide diameter implants did not affect its survival. The authors came to the conclusion that the use of a short and wide implant in the posterior maxilla or mandible where implant length maybe limited by the nerve or the sinus would not affect its survival.

Pommer B et al, 2016[37] a study in order to analyze prevailing trends like minimally invasive implant logy, virtual treatment planning and CAD/CAM stereo lithographic templates in clinical utilization. Short implants were predominantly used in the mandible while guided surgery was favored in the maxilla. They concluded that short implants and guided implant surgery represent uprising and promising surgical approaches to avoid patient morbidity associated with bone graft surgery.

Lemos CAA et al, 2016[38] conducted a study to compare short implants (equal or less than 8mm) versus standard implants (larger than 8mm) placed in posterior regions of maxilla and mandible, evaluating survival rates of implants, marginal bone loss, complications and prosthesis failures. The results showed that there was no significant difference of implants survival , marginal bone loss, complications and prosthesis failures. The authors concluded that short implants can be considered a predictable treatment for posterior jaws.

Grandi T et al, 2017[39] conducted a study on narrow diameter implants to evaluate whether they can be used as definitive implants in patients with insufficient bone ridge thickness in posterior regions of the mandible. They found that narrow-diameter implants (2.75 to 3.25mm) would be beneficial to decrease the rate of augmentations necessary for implant insertion. They concluded that after 1 year post loading narrow-diameter implants can be used successfully as a minimally invasive alternative to horizontal bone augmentation in the posterior mandible.

Pohl V et al, 2017[40] conducted a 3 year multi centre study to test whether the use of short dental implants (6 mm) results in an implant survival rate similar to that with longer implants(11-15 mm) in combination with sinus grafting. The assessed outcomes included were implant survival, marginal bone level changes, probing pocket depth, bleeding on probing and plaque accumulation. They concluded that short implants (6 mm) in the posterior maxilla as a viable solution versus long implants in combination with sinus lift.

Esfahrood ZR et al 2017[41] conducted a study to perform a literature review of short implants in the posterior maxilla and to assess the influence of different factors on implant success rate. A comprehensive search was conducted to retrieve articles published from 2004 to 2015 using short dental implants with lengths less than 10 mm in the posterior maxilla with at least one year of follow-up. The authors concluded that the survival rate of short implants in the posterior edentulous maxilla is high, and applying short implants under strict clinical protocols seems to be a safe and predictable technique.

Reich W et al 2017[42] conducted a study to evaluate the feasibility and safety of a new expandable short dental implant system intended to increase primary stability. From

2014 until 2015, 9 patients (7–9-mm vertical bone height) with 30 implants (length 5–7 mm, diameter 3.75–4.1 mm) were recruited consecutively. Implant stability shows high initial and secondary stability values. The authors concluded that the system might present an extension of functional rehabilitation to the group of elderly patients with limited vertical bone height.

Lombardo G et al 2017[43] conducted a study to determine cumulative success rate (CSR) of short and ultrashort implants in the posterior maxilla restored with single crowns. Success rate, clinical and radiographic outcomes, and crown-to-implant ratio (CIR) were assessed after three years. The authors suggested that short and ultrashort implants may be successfully placed and restored with single crowns in the resorbed maxillary molar region.

Papaspyridakos P et al 2018[44] conducted a study to review randomized controlled clinical trials (RCTs) reporting on the long-term survival and failure rates, as well as the complications of short implants (≤6 mm) versus longer implants (>6 mm) in posterior jaw areas. The short implant survival rate ranged from 86.7% to 100%, whereas standard implant survival rate ranged from 95% to 100% with a follow-up from 1 to 5 years. The authors concluded that short implants with ≤6 mm length should be carefully selected because they may present a greater risk for failure compared to implants longer than 6 mm.

Svezia L et al 2018[45] conducted a study to compare short (6 mm) with longer implants with the same surface use in the posterior maxilla and/or mandible. Outcomes measured were implant survival and marginal bone level changes up to 24 months after loading.The authors concluded that short implants may be successful in the posterior areas during the first 24 months of loading, with similar outcomes to 10 mm long implants, supporting their use as a valid option in selected cases.

Thoma DS et al 2018[46] conducted a study to compare the implant survival rate between short dental implants and standard length implants placed in combination with bone grafting at 5 years of loading. Patients randomly received either short implants (6 mm;) or long implants (11-15 mm) with sinus grafting. Both treatment modalities were suitable for implant therapy in the atrophied posterior maxilla revealing no differences in terms of survival rates, marginal bone levels (changes), patient-reported outcomes and technical/biological complications.

Al – Johany SS et al 2019[47] conducted a study to assess the survival rate of short dental implants (SDI; length ≤ 6.5 mm) placed in posterior edentulous ridges without any ridge augmentation procedures and the factors affecting their survival. The authors concluded that short dental implants placed in edentulous posterior regions of the maxilla and mandible have survival rates (96.45%) similar to those of conventional-length implants after a follow-up period of 12 months post-prosthetic loading. The other variables relating to implant surgery, prosthetic loading, nature and type of prosthesis, and follow-up did not significantly affect short implants survival.

Bitaraf T et al 2019[48] conducted a study to compare short implants (4-8 mm) to standard implants (longer than 8 mm) in edentulous jaws, evaluating pri-implant marginal bone levels (MBLs) changes, implant failures (IFs), complications, and prosthesis failures. The authors concluded that short dental implants and standard dental implants showed comparable outcomes except biological complication preferring short dental implants.

Ravida A et al 2019[49] conducted a meta-analysis of randomized clinical trials comparing clinical and patient-reported outcomes between extra-short (≤6 mm) and longer (≥10 mm) implants with and without bone augmentation procedures. A systemic literature search of randomized clinical trials was performed using the PubMed (MEDLINE) and EMBASE databases. They concluded that placement of extra-short implants (≤6 mm) presented as an equivalent option in the treatment of patients with an atrophic posterior arch up to 3-year follow-up.

Altaib F et al 2019[50] conducted a study to evaluate if short implants without augmentation can be considered a successful alternative treatment modality in the rehabilitation of posterior atrophic ridges when compared to standard-length implants with augmentation. The authors concluded that short dental implants seem to be an effective alternative treatment for the atrophic posterior ridge. The data also revealed that short dental implants have statistically less marginal bone loss and fewer postoperative complications when compared to standard-length dental implants with augmentation.

MATERIAL AND METHODS

STUDY SETTING

The study was conducted in the Department of Periodontology, Babu Banarasi Das College of Dental Sciences, Lucknow, Uttar Pradesh. The study was commenced after the clearance from the Institutional Ethical committee and approval from BBD University.

STUDY DESIGN

The study design was naïve direct comparison in which only the concerned treatment (i.e., placement of _ultra-short implants') was done and the results of present study were compared to previous data from a well known systematic review by Lemos et al 2016.

1. *Experimental group:* Ultra-short implant of 5.0 x 5.0 mm was placed in posterior edentulous mandibular ridge
2. *Control group:* Previously placed conventional implants in posterior edentulous mandibular ridge

STUDY POPULATION

The study population included the subjects selected from the patients visiting the Department of Periodontology, Babu Banarasi Das College of Dental Sciences, Lucknow, Uttar Pradesh. 10 patients (6 males and 4 females; age range: 25-65 years) each with partially edentulous posterior ridge were enrolled in this longitudinal study.

SUBJECT SELECTION

INCLUSION CRITERIA

1. Systemically and orally healthy patients.
2. A good level of oral hygiene (full mouth plaque and gingival index scores <1).
3. Age 25 – 65 years
4. Partially Edentulous Posterior Ridge with at least 8mm horizontal dimension at crest
5. Vital structures (maxillary sinus and inferior alveolar nerve canal) at least 8mm from the crest of the ridge
6. Inter occlusal space of ≥ 7mm
7. Presence of antagonist teeth
8. Adequate patient compliance

EXCLUSION CRITERIA

1. Presence of any systemic illness known to affect the normal healing mechanism or bone metabolism or tobacco consumption of any type.
2. Immuno-compromised individuals.
3. Pregnant and Lactating females.
4. Patients taking any drugs (steroids, anticoagulants, anti-epileptics etc.) which are known to affect the healing and clotting mechanisms, causing gingival enlargement.

Armamentarium for Diagnosis and Pre-clinical Assessment:

- Mouth mirror
- Hu- Friedy‘s UNC 15 graduated periodontal probe
- Tweezers
- Metallic scale
- Hard tissue caliper (GDC Marketing , India)
- Digital OPG
- Diagnostic casts

Armamentarium for surgery:

- Local anesthesia (Xylocaine 2% with Adrenaline)
- Syringe 3ml
- Saline
- Bard Parker Handle
- Blade (no.11.12.15)
- Periosteal elevator
- Tissue holding forceps
- Castroviejo scissors
- Castroviejo needle holder
- Suture material (4-0 Ethicon)
- Suture cutting scissors
- Implant kit (Bicon SHORT Implant)

SAMPLE SIZE

Sample size $n = \{Z^2_{(1-\alpha)/2} . S^2\}/ d^2$

Where n = Required sample size

$Z_{(1-\alpha)/2}$ = Standard normal variate ($\alpha = 0.05$)

S = Estimated standard deviation

d = Absolute error or Desired precision

Total Number of Patients: **10**

Prior to initiating the study, the patients were informed of the purpose and design of this clinical study and were required to sign a written informed consent form. A thorough medical and dental history was taken from each patient and a detailed clinical examination including initial radiographs was performed.

METHODOLOGY

INITIAL THERAPY

All 10 patients (6 males and 4 females) with partially edentulous posterior ridges, following an initial examination, diagnosis and treatment planning were subjected to phase-I therapy which consisted of full mouth scaling and root debridement using hand and ultrasonic instruments. Detailed oral hygiene instructions were given to all the patients. Patients were kept on continuous follow-up evaluations every 2 weeks. Oral hygiene instructions were reinforced on every follow-up appointment until every patient maintained a good oral hygiene (full mouth plaque and gingival index score <1).

CLINICAL PARAMETERS AT 3-,6-,9-,12-MONTHS POST LOADING

Upon completion of the initial phase of therapy, the suitability of the sites for the study was confirmed and following clinical parameters were assessed

- **Modified PI ($mPI_3 mPI_6 mPI_9 \& mPI_{12}$) (Mombelli et al. 1987)**
- **Modified GI ($mGI_3 mGI_6 mGI_9 \& mGI_{12}$) (Mombelli et al. 1987)**
- **Probing Pocket Depth ($PPD_3 PPD_6 PPD_9 \& PPD_{12}$)**
- **Implant Mobility ($M_3\ M_6\ M_9\ M_{12}$)**

mPI&mGI*(Mombelli et al. 1987)*

A mouth mirror and a dental explorer were used, after air drying of the area lightly to assess plaque. Four surfaces were examined (Facial, Lingual, Mesial & Distal).

Score	**Mombelli et al (mPI)**
0	No detection of plaque
1	Plaque only recognized by running a probe across the smooth marginal surface of the implant
2	Plaque can be seen by the naked eye
3	Abundance of soft matter

Score	**Mombelli et al (mGI)**
0	No bleeding when a periodontal probe is passed along the mucosal margin adjacent to the implant
1	Isolated bleeding spots visible
2	Blood forms a confluent red line on mucosal margin
3	Heavy or profuse bleeding

PROBING MEASUREMENTS

PPD (probing pocket depth) was determined at baseline and at 1-year by using **UNC-15 graduated periodontal probe. *Hu-friedy*** and were recorded to the nearest millimeter. All the 4 sites (mesio-buccal, mid-buccal, disto-buccal and mid-lingual) per tooth were examined for PPD and the site with deepest findings was included in the study.

- ✓ ***(PPD)**: Probing pocket depth (PPD) was measured using the gingival margin as reference*

Customized acrylic stents were not used for the reproducibility of the probing angulation at two time points (baseline and 6 months) as there are certain drawbacks of stent usage. Stents are usually stored for about 6 months or more and the stents, in most of the cases are made up of self-cure acrylic resins which has a greater dimensional instability as compared to heat-cure acrylic (due to higher residual free monomer ratio of 3-5% in self-cure acrylic as compared to 0.2-0.5% in heat-cure acrylic)[51]. Using a heat-cure acrylic to prepare occlusal stents is clinically impractical. Hence, self-cure acrylic stents usually get distorted on storage for a long time span (≥6 months) changing the adaptation of stent on the occlusal surface which further changes the probing angulation thus hampering the standardization.

RADIOGRAPHIC PARAMETERS AT 3-,6-,9-,12-MONTHS POST LOADING

RVG Imaging:

An IOPA image was captured with paralleling technique (owing to its reproducibility) using *Unicorn RVG sensor, Geno-ray Portable Xray Unit X-II, XCP RVG-sensor Positioner, and a Grid.* For reproducibility of bite at 1-year, we used a Polyether bite registration paste for every case (owing to its long-term stability) [Figure-1].

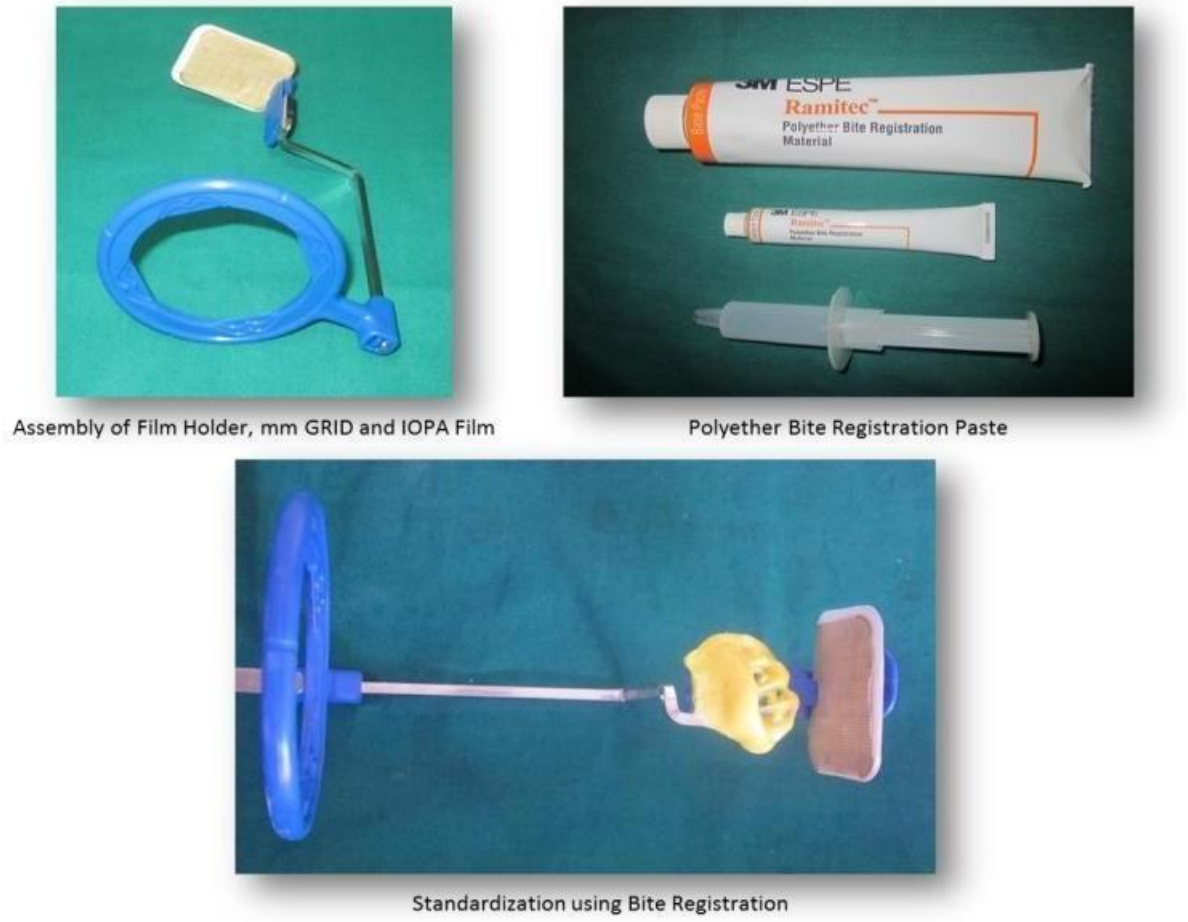


Figure-1: Armamentarium & procedure for obtaining well standardized radiograph.

Image obtained were analysed for radiographic parameter- MARGINAL BONE-LOSS (MBL) as below [Figure-2].

- ***Marginal Bone Loss (MBL_3, MBL_6, MBL_9& MBL_{12}):*** *The coronal surface of the implant (yellow line) was taken as the reference line from which 2 perpendicular lines (red lines) were dropped on the mesial and distal aspect of the implants to the first bone-to-implant contact. Comparative measurements of mesial and distal crestal bone levels adjacent to implants were made to the nearest 0.1 mm. A minimum of 3 readings were made for each case and the average values were used to calculate the amount of crestal bone loss. Subtracting the bone level at previous follow-up from the recent one gave the bone loss.*

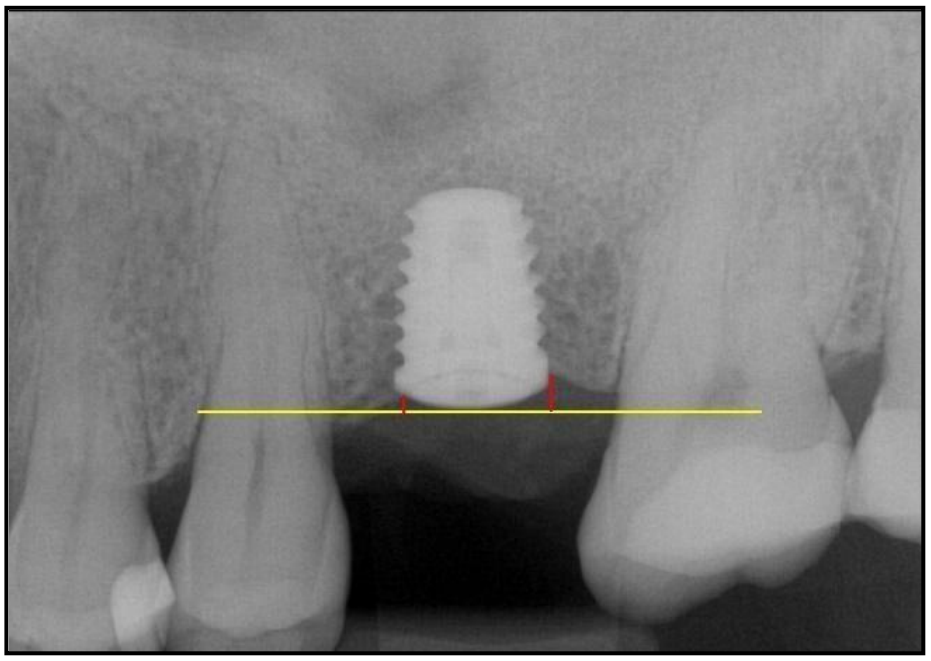


Figure-2: Radiographic measurements

SURGICAL PROCEDURE [Photoplates 1-5]

Following clinical data collection, surgical preparation was done including pre-operative mouth rinsing with 10 ml of 0.2 % chlorhexidine digluconate solution *(Hexidine^{TM}),*facial scrubbing with 5% povidone iodine*(5% Betadine^{TM}).*Asepsis was maintained through-out the surgical procedure. Area subjected to surgery was anaesthetized by nerve block depending on the site using 2% Xylocaine containing adrenaline at a concentration of 1:200,000 (*Astra Zeneca Pharma India Ltd.).* A mid crestal incision was given using #15 BP blade followed by elevation of a buccal and lingual mucoperiosteal flap using Molt's periosteal elevator*(Hu-friedy^{TM})* which gave direct visual access to the surgical site.

IMPLANT SYSTEM –

A locking taper (Morse taper or Morse cone) uni-module design dental implant system *(Bicon® Dental Implants, Boston, MA, United States)* which was designed in 1985 was used. A locking taper connection has an advantage of a proven bacterial seal[52]. The implant system has a convergent crest module, root form plateau design and platform switching. Complete implant design is explained in figure 3.

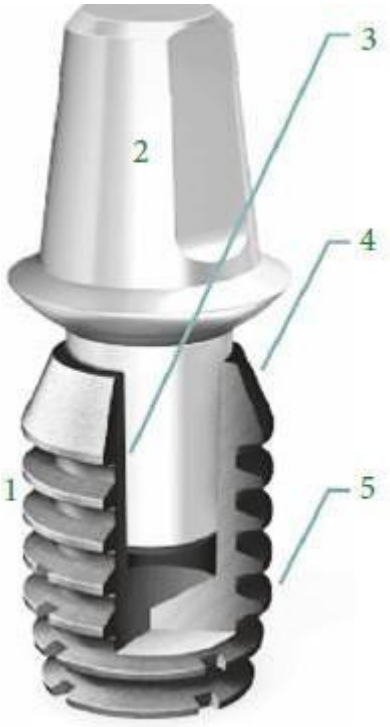


Figure-3: Schematic drawing of the Bicon® dental implant system and its macro-geometric features

1.Represents the short root-plateau form implant body.

2.Represents the abutment.

3.Represents the 1.5° internal connection (locking-taper)

4.Indicates the convergent crest module (sloping shoulder)

5. Represents the implant plateaus.

CONTENTS OF BICON IMPLANT KIT [Photoplate-1]
Bicon® Dental Implants, Boston, MA, United States

1. Shoulder depth gauge
2. Removal wrench
3. Double ended osteotomy depth gauge
4. Threaded straight handle
5. Implant insertion / Retrievers
6. Threaded offset handle
7. Latch reamers
8. Latch reamer extension
9. Pilot drills
10. Healing plug removal instrument
11. Paralleling pins
12. Osteotomes
13. Implant / abutment seating tips
14. Threaded instrument adapter
15. Hand reamers
16. Guide pins
17. Sulcus reamers
18. Threaded knob

The osteotomy was started with pilot drill (1100 rpm) with an intermittent pressure of 1 second on the bone and 1 to 2 seconds off the bone. The high-speed drill was used with external saline irrigation and had a cutting edge at the apical portion. The final pilot drilling length was calculated by adding 3 mm to the selected implant length. After pilot drilling, a periapical radiograph was obtained to control vertical and horizontal positions with regard to adjacent vital anatomical structures. Latch reamers were used to widen the osteotomy at 50 rpm without external irrigation. The length of the latch reamers was set at the computed final drilling length. The latch reamers are designed with a 0.5 mm diameter progressive increase and were used until the final implant diameter was reached. We collected autogenous bone from the latch reaming process as latch reamers do not need external irrigation and have low RPMs (A silicone Dappen dish was used to store the bone during the procedure).

Then the selected implant (Bicon Dental Implants,Boston, MA, USA) measuring 5.0 x 5.0 mm was manually inserted into the osteotomy through the healing plug. The healing plug was cut ensuring that no sharp edges were present and could irritate the soft tissue. The harvested bone was placed over and around the implant shoulder.

POST-SURGICAL CARE

Each patient was kept under an antibiotic coverage *(Amoxicillin 500mg TDS 5-days)*. Post-operative pain and oedema were controlled by prescribing a non steroidal anti-inflammatory drug (*Diclofenac 50mg BD 3-days*, followed by SOS)

Chlorhexidine digluconate mouthrinse (0.2%, 12 hourly for 4-weeks post-surgery) was prescribed to the patient. Also, the patient was refrained from tooth brushing, flossing, and other interdental cleaning aids in the surgical area for 1-week post-surgery.

All other post-operative instructions were given to the patient in writing.

POST-SURGICAL FOLLOW UP AND MAINTENANCE

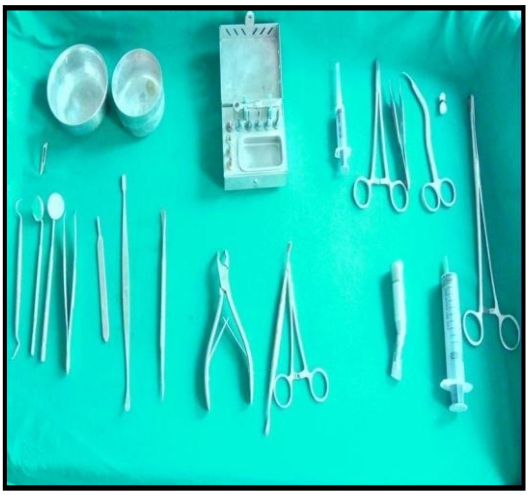
Sutures were removed 1-week post-surgery. The surgical wound was then gently cleansed with 2% povidone-iodine solution. Each patient was instructed to initiate mechanical oral hygiene, consisting of gentle tooth brushing using Charter‘s

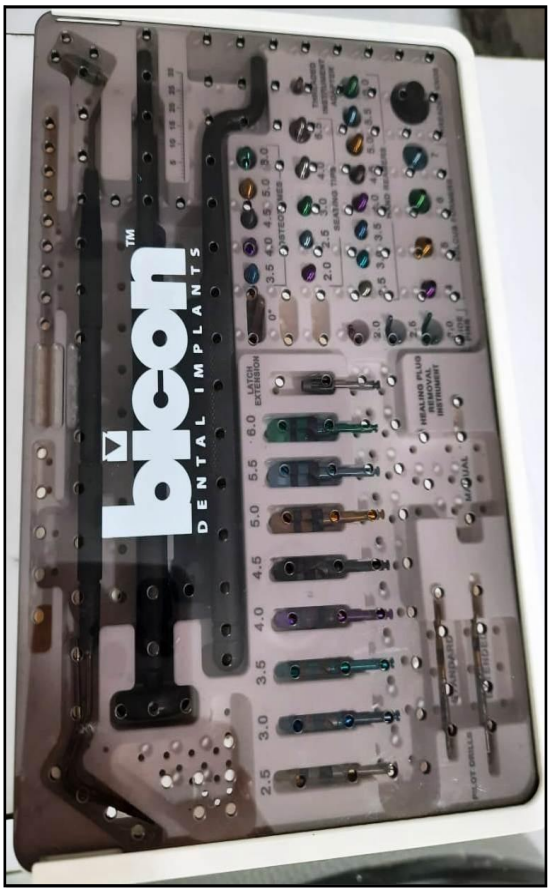
technique with a soft toothbrush and not use any type of interdental cleaning aids in the treated area for a period of 4-weeks post-surgery.

Recall appointments were scheduled for re-evaluation at 2 weeks, 1-3-6 months, and finally at 1-year interval from the day of surgery. Postoperative care also included the reinforcement of oral hygiene instructions at each appointment and in-office plaque removal when- and where-ever necessary.

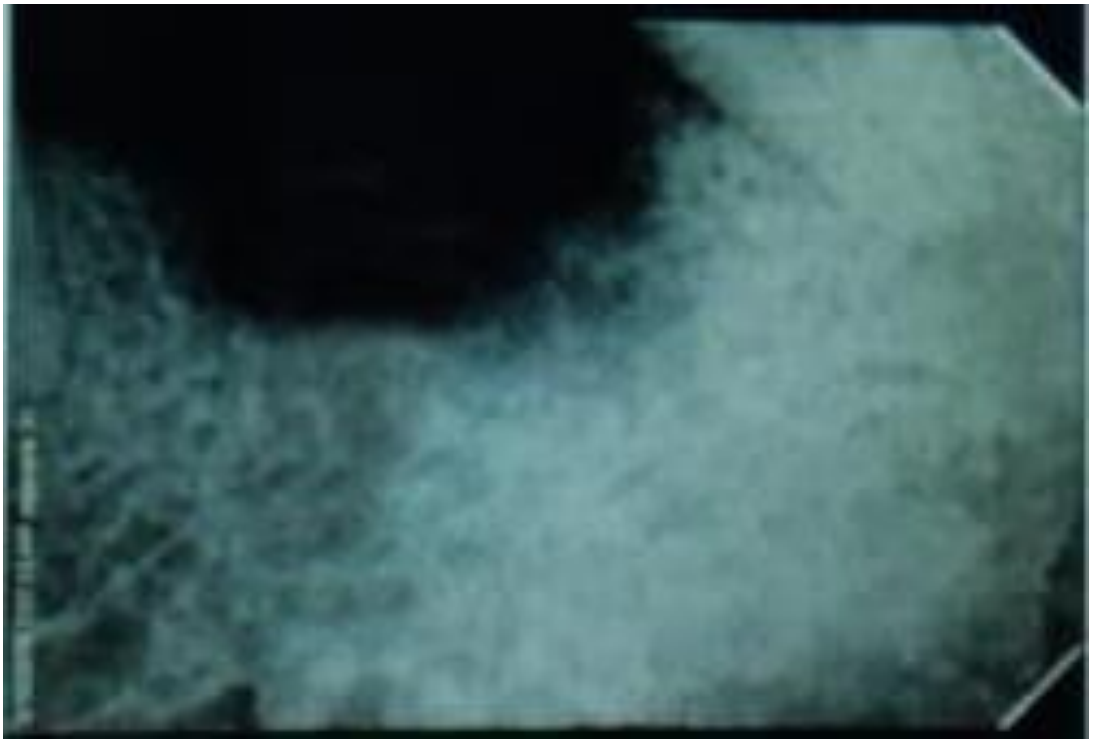
The implants were uncovered after 4 months of healing period. Temporary abutments were placed, flaps were re-adapted, and sutures were placed around the temporary abutments. Definitive impressions were made after 3 weeks of soft tissue healing. Porcelain fused to metal (PFM) crowns were delivered within 2 weeks. Occlusal adjustments were made, and prosthetic restorations were checked for loosening, chipping or other prosthetic complications at each recall appointment thereafter.

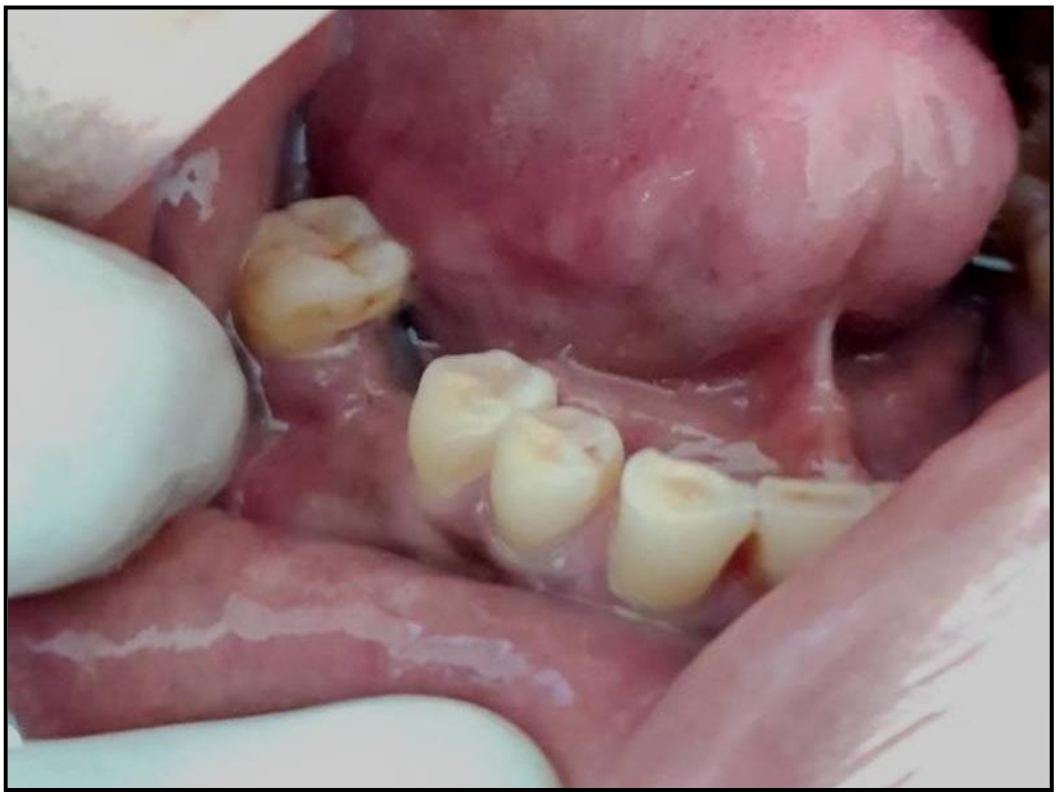
All the clinical and radiographic parameters were measured at baseline and at 1 year as discussed previously.





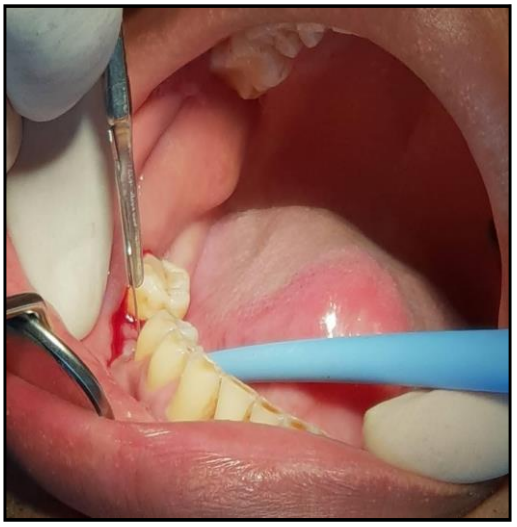
PHOTOPLATE-1: SURGICAL KIT AND ARMAMENTARIUM



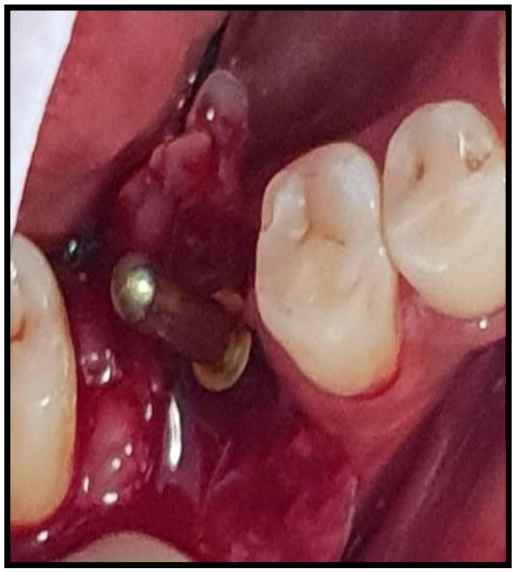


PHOTOPLATE-2: PRE-OPERATIVE CLINICAL & RADIOGRAPHIC IMAGE OF THE CASE

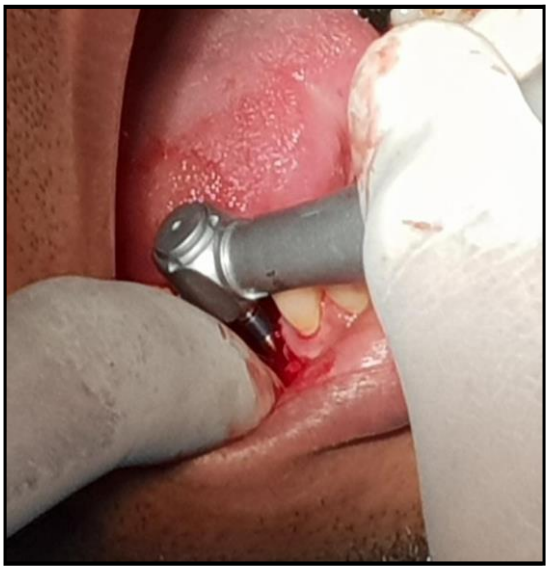
Bone Mapping



Mid-crestal Incision with #15 BP Blade

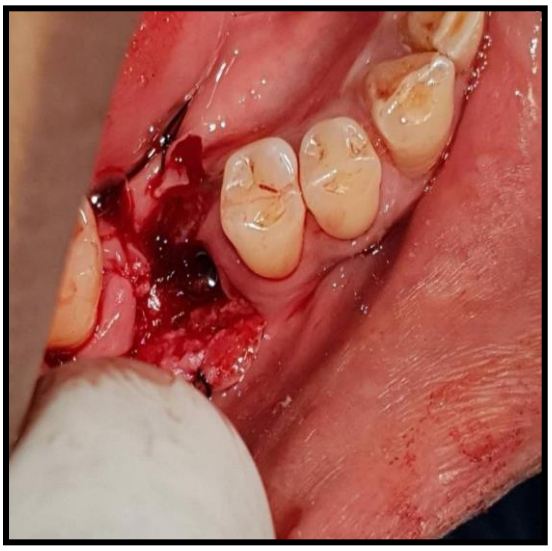


Guide-pin for judging Parallelism

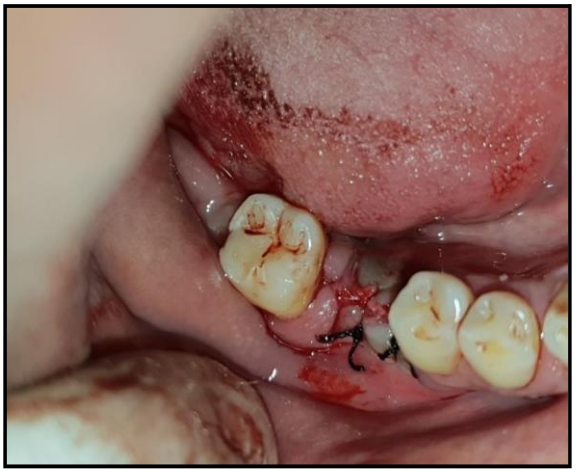


Sequential Drilling

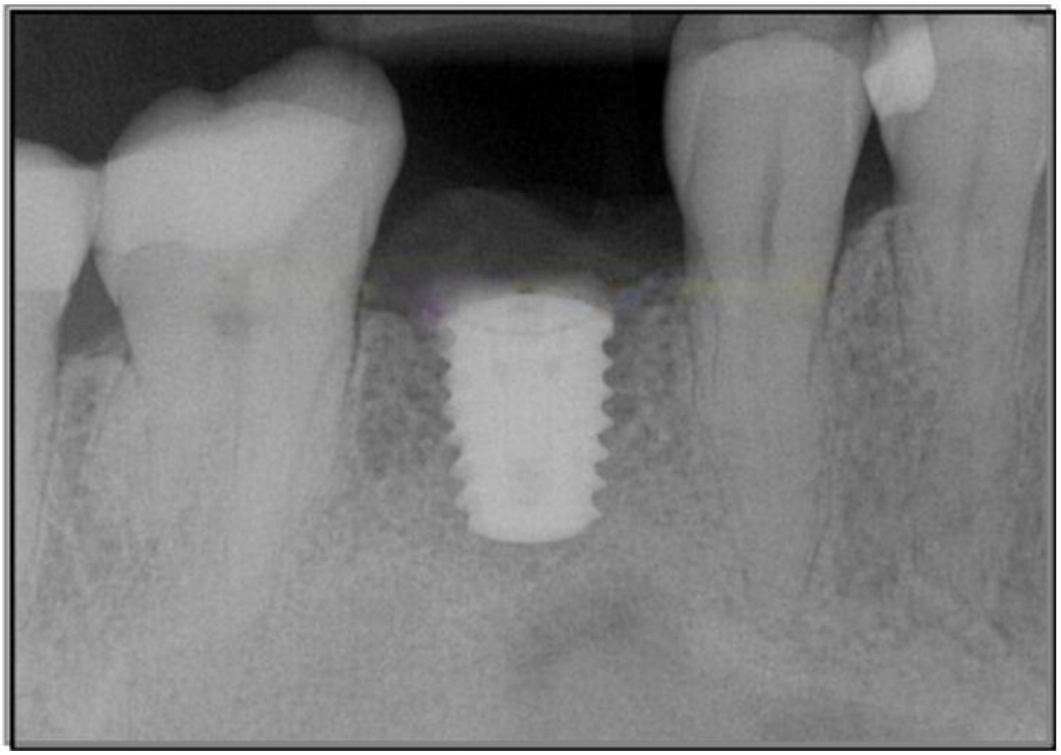
PHOTOPLATE-3: Surgical Procedure



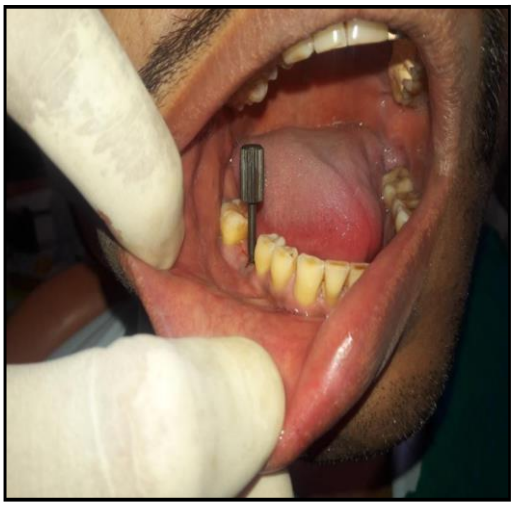
Implant Inserted

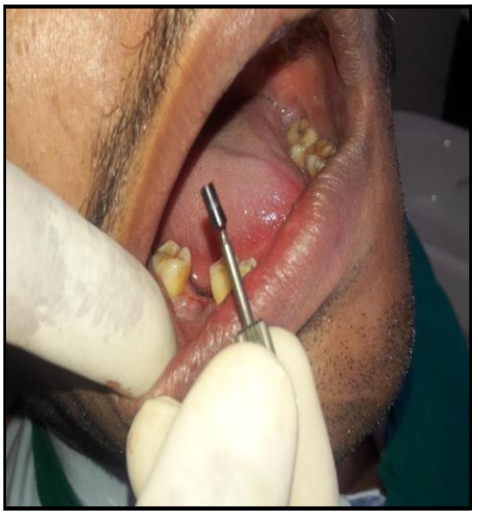


Direct Loop Sutures in Place

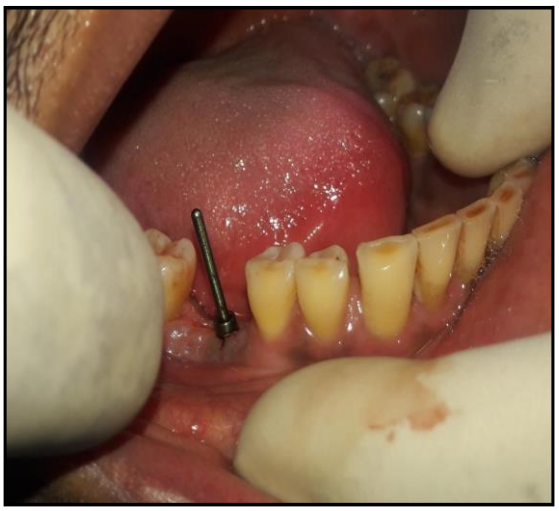


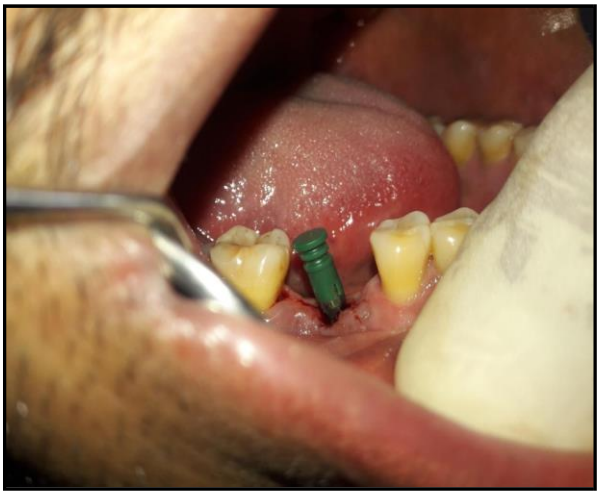
PHOTOPLATE-4: Post-operative Clinical & Radiographic Image





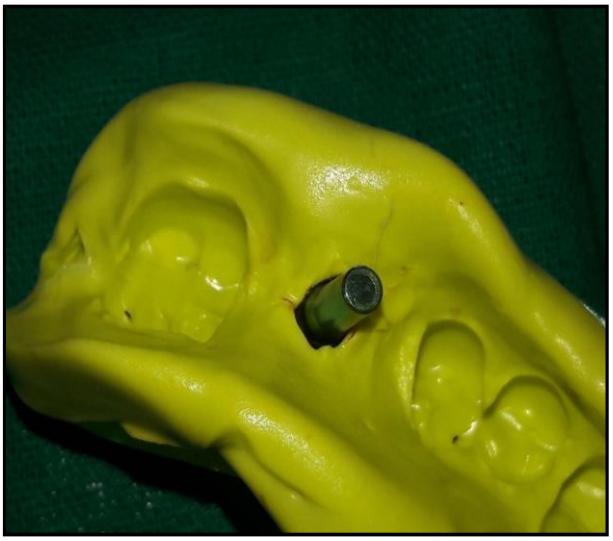
Removal of the healing plug from the instrument's well

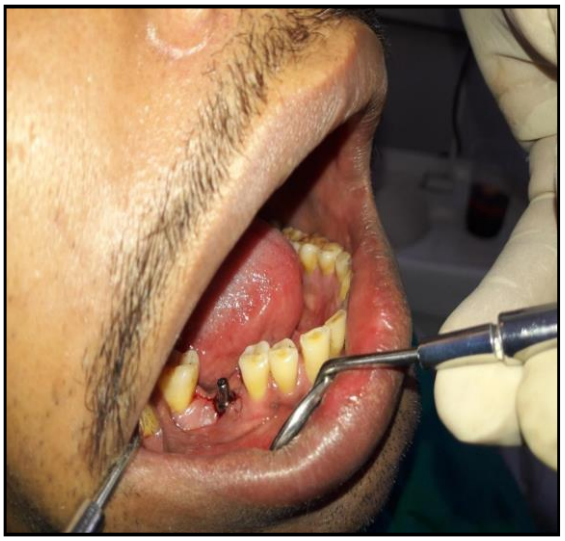




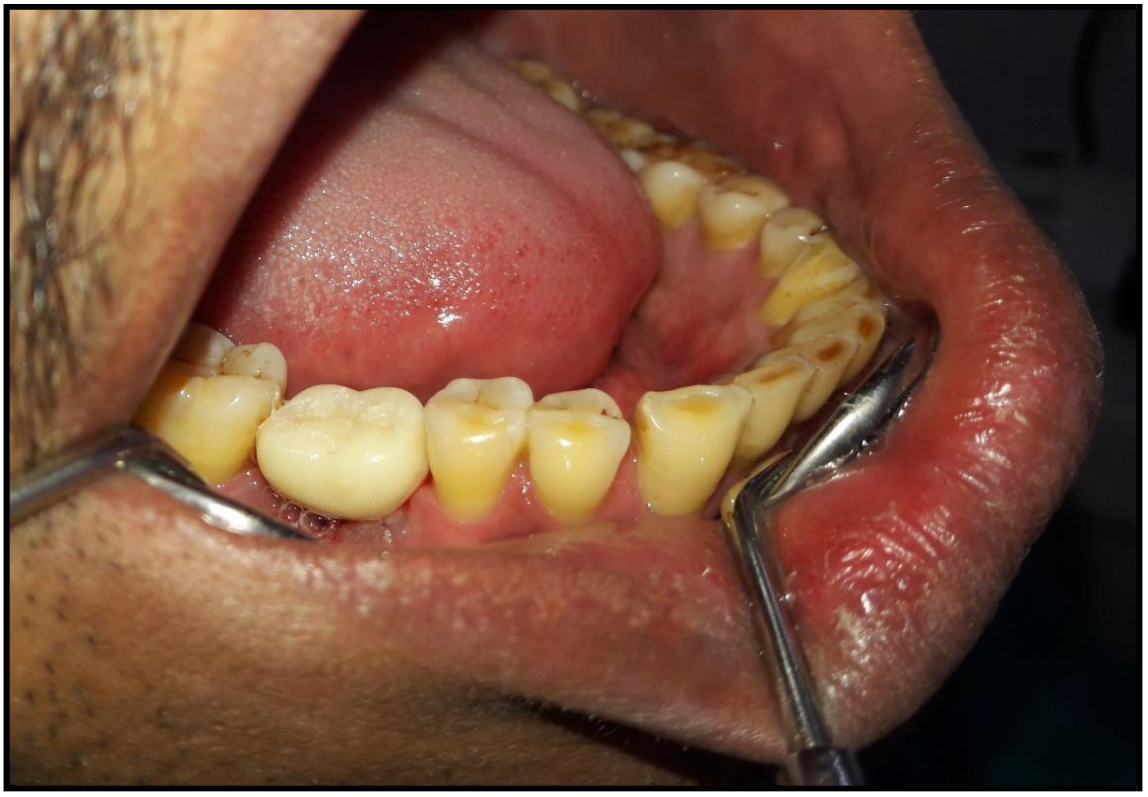
- **placing of guide pins which are used as aguide for sulcus reamers.**
- **placement of sulcus reamers which are usedto remove any soft tissue or bone above the implant.**

PHOTOPLATE-5a: SECOND STAGE PROCEDURE





- **Definitive Impressions made**
- **Temporary Abutment placed**



PHOTOPLATE-5b: Prosthesis Fabrication

RESULTS AND OBSERVATIONS

The present clinical and radiographic study evaluates efficacy of Ultra short dental implants vs. Conventional dental implants. Total 10 implants in the patients of either sex, more than 18 years of age having a partially edentulous ridge with at least 8mm horizontal dimension at crest were placed. The vital structures like maxillary sinus and inferior alveolar canal should be at least 8mm from the crest of the ridge and without any contraindication for minor oral surgery and/or local or general anesthesia, or allergy to titanium were recruited. The patients with the placement of ultra short implants of 5.0 x 5.0 mm in the posterior mandibular edentulous arch was considered as the experimental group and the patients with previously placed conventional implants in posterior mandibular edentulous arch was considered as the control group.

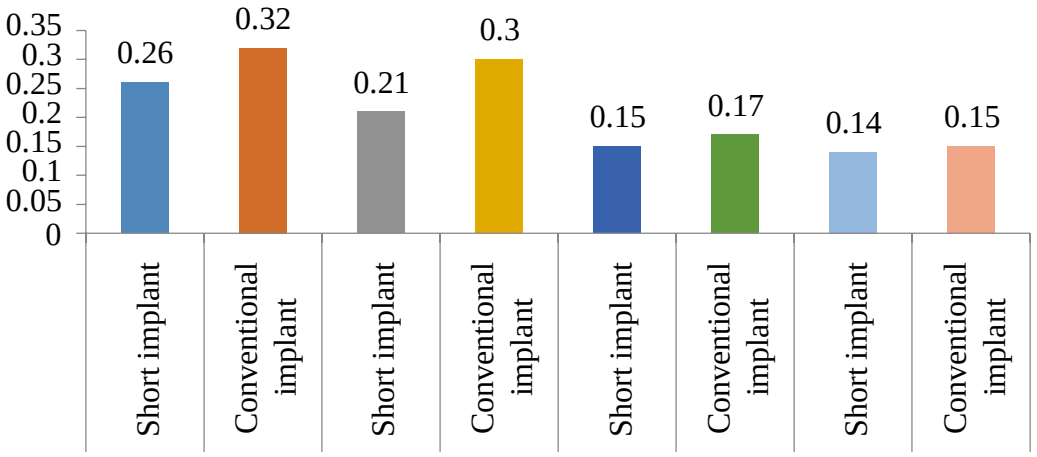
The clinical and radiographic parameters assessed at baseline and at 1 year were Marginal bone loss, Implant mobility, Plaque index, Bleeding on probing and Probing pocket depth around implants. The objective of the study was to compare the outcome measures between two groups (Group A and Group B).

Basic characteristics

The basic characteristics like Marginal bone loss, Implant mobility, Plaque index, Bleeding on probing and Probing pocket depth around implants of two groups at presentation is summarised below. Comparing the basic characteristics of two groups, the basic characteristics were found similar ($p>0.05$) between the two groups i.e. did not differ significantly. In other words, subjects of two groups were matched and comparable and thus may also not influence the study outcome measures.

Table-1: Comparison of Short Implant and Conventional Implant at the follow up periods with respect to Marginal Bone Loss

PARAMETER	FOLLOW UP PERIOD	IMPLANT	Mean	Std. Deviation	Mean difference	P value
Marginal Bone Loss	3 months	Short	0.26	0.14	0.06	0.380, NS
		Conventional	0.32	0.15		
	6 months	Short	0.21	0.07	0.09	0.088, NS
		Conventional	0.3	0.13		
	9 months	Short	0.15	0.11	0.02	0.665, NS
		Conventional	0.17	0.09		
	12 months	Short	0.14	0.05	0.01	0.777, NS
		Conventional	0.15	0.09		



Graph-1: Comparison of Short Implant and Conventional Implant at the followup periods with respect to Marginal Bone Loss

At 3 months follow up, the mean marginal bone loss is found to be 0.26(±0.14) in the short implant group and 0.32(±0.15) in the conventional implant group. The difference of 0.06 between the mean values of the two groups is found to be statistically not significant (p = 0.380) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to marginal bone loss at the 3 month follow up period.

At 6 months follow up, the mean marginal bone loss is found to be 0.21(±0.07) in the short implant group and 0.3(±0.13) in the conventional implant group. The difference of 0.09between the mean values of the two groups is found to be statistically not significant (p = 0.088) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to marginal bone loss at the 6 month follow up period.

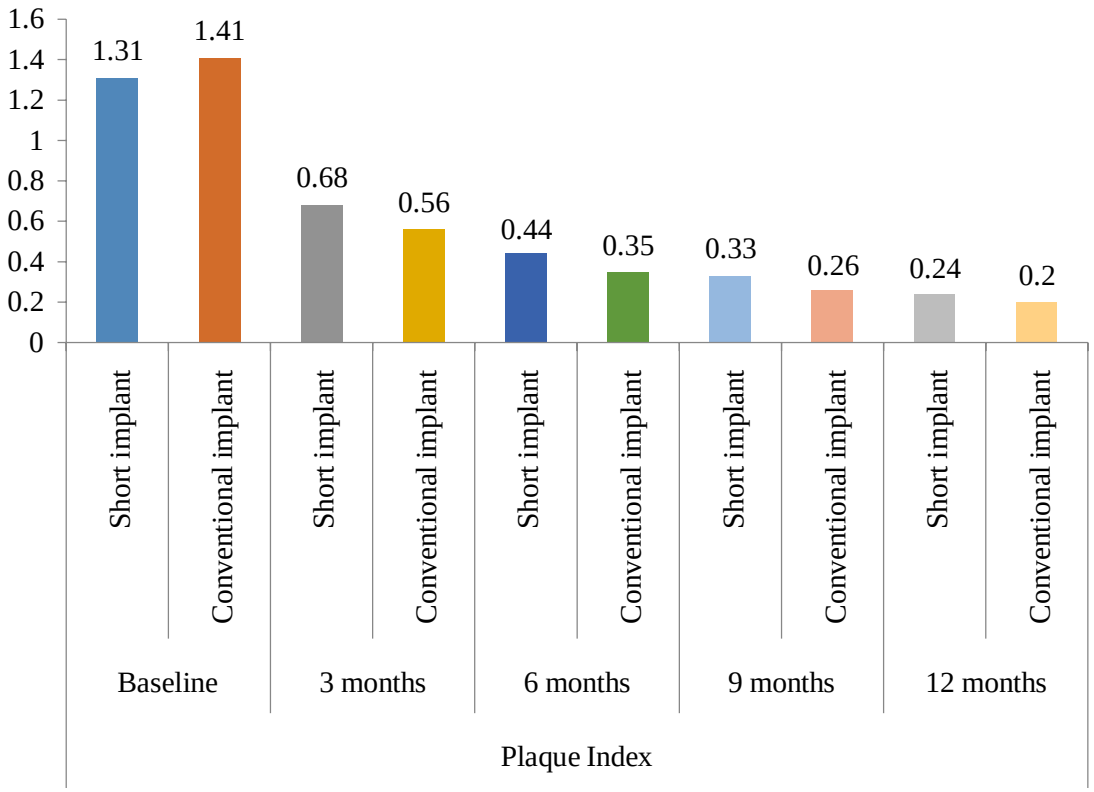
At 9 months follow up, the mean marginal bone loss is found to be 0.15(±0.11) in the short implant group and 0.17(±0.09) in the conventional implant group. The difference of 0.02between the mean values of the two groups is found to be statistically not significant (p = 0.665) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to marginal bone loss at the 9 month follow up period.

At 12 months follow up, the mean marginal bone loss is found to be 0.14(±0.05) in the short implant group and 0.15(±0.09) in the conventional implant group. The difference of 0.01 between the mean values of the two groups is found to be statistically not significant (p = 0.777) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to marginal bone loss at the 12 month follow up period. **(Table 1; Graph 1)**

Thus, there is no statistically significant difference between short implants and conventional implants with respect to marginal bone loss at any of the follow up periods.

Table-2: Comparison of Short Implant and Conventional Implant at the follow up periods with respect to Modified Plaque Index (Mombelli et al. 1987)

PARAMETER	FOLLOW UP PERIOD	IMPLANT	Mean	Std. Deviation	Mean difference	P value
mPI	3 months	Short	0.68	0.18	0.12	0.132, NS
		Conventional	0.56	0.16		
	6 months	Short	0.44	0.13	0.09	0.117, NS
		Conventional	0.35	0.11		
	9 months	Short	0.33	0.17	0.07	0.229, NS
		Conventional	0.26	0.05		
	12 months	Short	0.24	0.12	0.04	0.361, NS
		Conventional	0.20	0.07		



Graph-2: Comparison of Short Implant and Conventional Implant at the followup periods with respect to Modified Plaque Index (Mombelli et al. 1987)

At 3 months follow up, the mean plaque index is found to be 0.68(±0.18) in the short implant group and 0.56(±0.16) in the conventional implant group. The difference of

0.12between the mean values of the two groups is found to be statistically not significant (p = 0.132) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to plaque index at the 3 month follow up period.

At 6 months follow up, the mean plaque index is found to be 0.44(±0.13) in the short implant group and 0.35(±0.11) in the conventional implant group. The difference of 0.09between the mean values of the two groups is found to be statistically not significant (p = 0.117) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to plaque index at the 6 month follow up period.

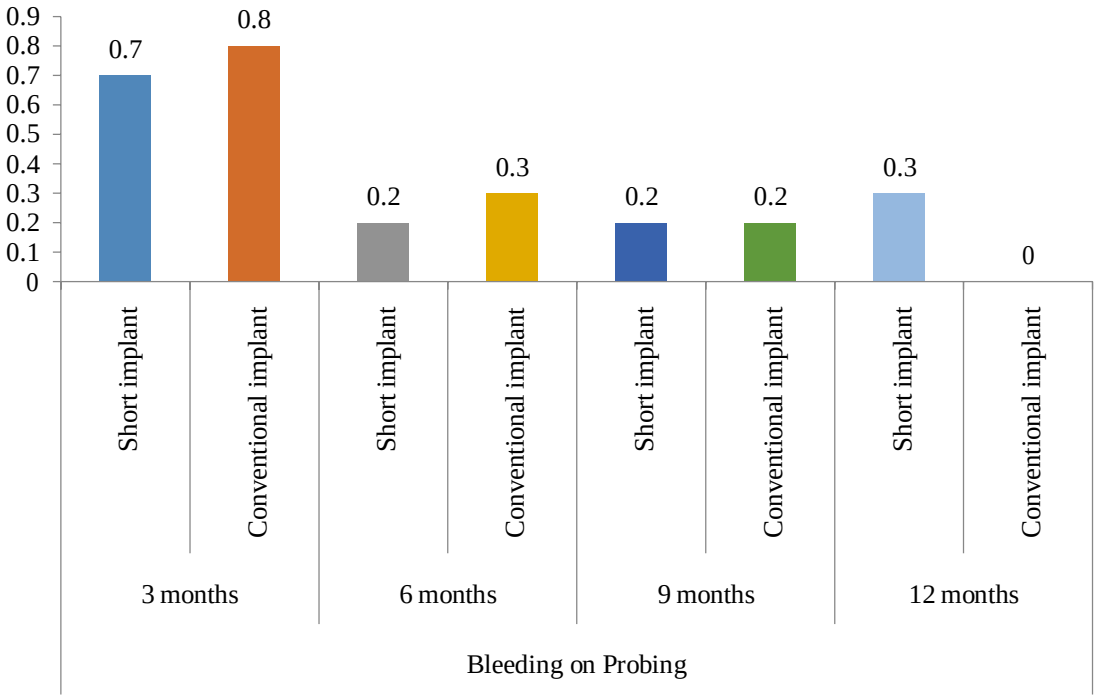
At 9 months follow up, the mean plaque index is found to be 0.33(±0.17) in the short implant group and 0.26(±0.05) in the conventional implant group. The difference of 0.07between the mean values of the two groups is found to be statistically not significant (p = 0.229) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to plaque index at the 9 month follow up period.

At 12 months follow up, the mean plaque index is found to be 0.24(±0.12) in the short implant group and 0.20(±0.07) in the conventional implant group. The difference of 0.04between the mean values of the two groups is found to be statistically not significant (p = 0.361) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to plaque index at the 12 month follow up period. **(Table 2; Graph 2)**

Thus, there is no statistically significant difference between short implants and conventional implants with respect to plaque index neither at baseline nor at any of the follow up periods.

Table-3: Comparison of Short Implant and Conventional Implant at the follow up periods with respect to Modified Gingival Index (Mombelli et al. 1987)

PARAMETER	FOLLOW UP PERIOD	IMPLANT	Mean	Std. Deviation	Mean difference	P value
mGI	3 months	Short	0.70	0.48	0.10	0.628, NS
		Conventional	0.80	0.42		
	6 months	Short	0.20	0.42	0.10	0.628, NS
		Conventional	0.30	0.48		
	9 months	Short	0.20	0.42	0.00	1.00, NS
		Conventional	0.20	0.42		
	12 months	Short	0.30	0.48	0.30	0.065, NS
		Conventional	0.00	0.00		



Graph-3: Comparison of Short Implant and Conventional Implant at the followup periods with respect to Modified Gingival Index (Mombelli et al. 1987)

At 3 months follow up, the mean bleeding score was found to be 0.70(±0.48) in the short implant group and 0.80(±0.42) in the conventional implant group. The

difference of 0.10between the mean values of the two groups is found to be statistically not significant (p = 0.628) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to mGI at the 3 month follow up period.

At 6 months follow up, the mean bleeding score was found to be 0.20(±0.42) in the short implant group and 0.30(±0.48) in the conventional implant group. The difference of 0.10between the mean values of the two groups is found to be statistically not significant (p = 0.628) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to mGI at the 6 month follow up period.

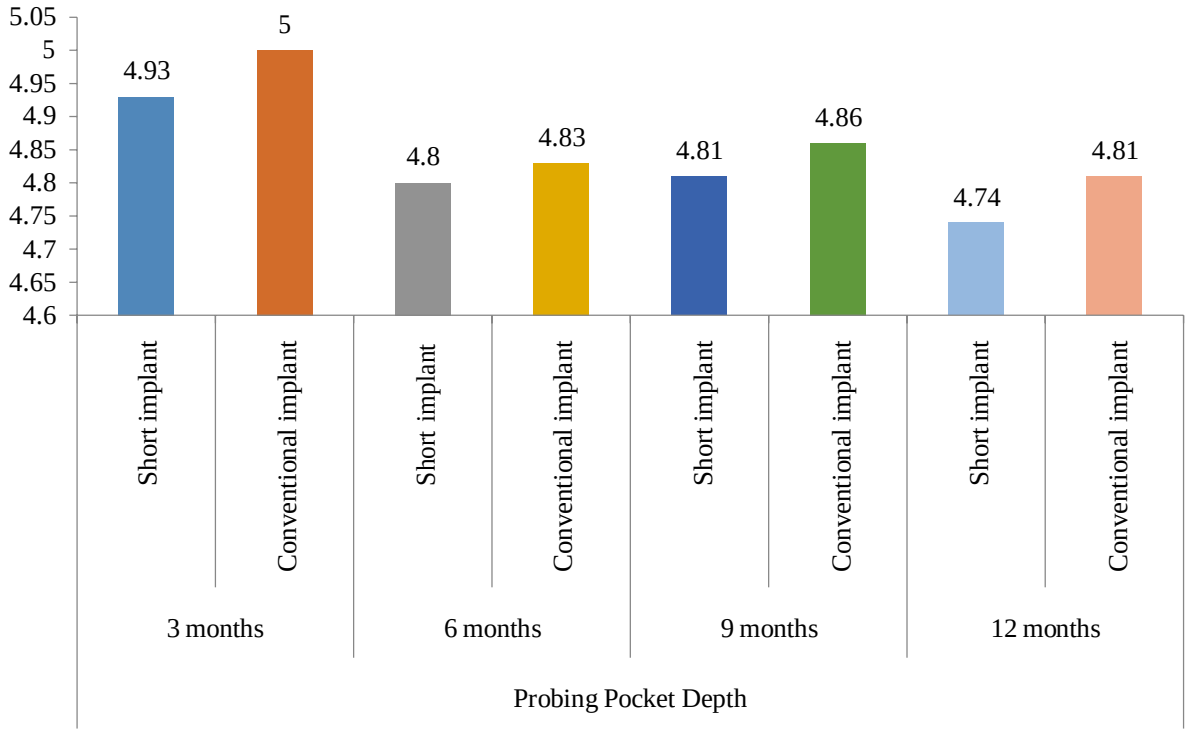
At 9 months follow up, the mean bleeding score in the short implant group and in the conventional implant group are both found to be 0.20(±0.42). The difference is statistically not significant (p = 1.00) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to mGI at the 9 month follow up period.

At 12 months follow up, the mean bleeding score was found to be 0.30(±0.48) in the short implant group and 0 in the conventional implant group. The difference of 0.30between the mean values of the two groups is found to be statistically not significant (p = 0.065) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to mGI at the 12 month follow up period. **(Table 3; Graph 3)**

Thus there is no statistically significant difference between short implants and conventional implants with respect to mGI (bleeding on probing) at any of the follow up periods.

Table-4: Comparison of Short Implant and Conventional Implant at the follow up periods with respect to Probing Pocket Depth

PARAMETER	FOLLOW UP PERIOD	IMPLANT	Mean	Std. Deviation	Mean difference	P value
PPD	3 months	Short	4.93	0.37	-0.07	0.671, NS
		Conventional	5.00	0.35		
	6 months	Short	4.80	0.41	-0.03	0.868, NS
		Conventional	4.83	0.39		
	9 months	Short	4.81	0.41	-0.05	0.791, NS
		Conventional	4.86	0.42		
	12 months	Short	4.74	0.42	-0.07	0.723, NS
		Conventional	4.81	0.45		



Graph-4: Comparison of Short Implant and Conventional Implant at the followup periods with respect to Probing Pocket Depth

At 3 months follow up, the mean probing pocket depth is found to be 4.93(±0.37) in the short implant group and 5.00(±0.35) in the conventional implant group. The difference of 0.07between the mean values of the two groups is found to be statistically not significant (p = 0.671) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to probing pocket depth at the 3 month follow up period.

At 6 months follow up, the mean probing pocket depth is found to be 4.80(±0.41) in the short implant group and 4.81(±0.39) in the conventional implant group. The difference of 0.03between the mean values of the two groups is found to be statistically not significant (p = 0.868) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to probing pocket depth at the 6 month follow up period.

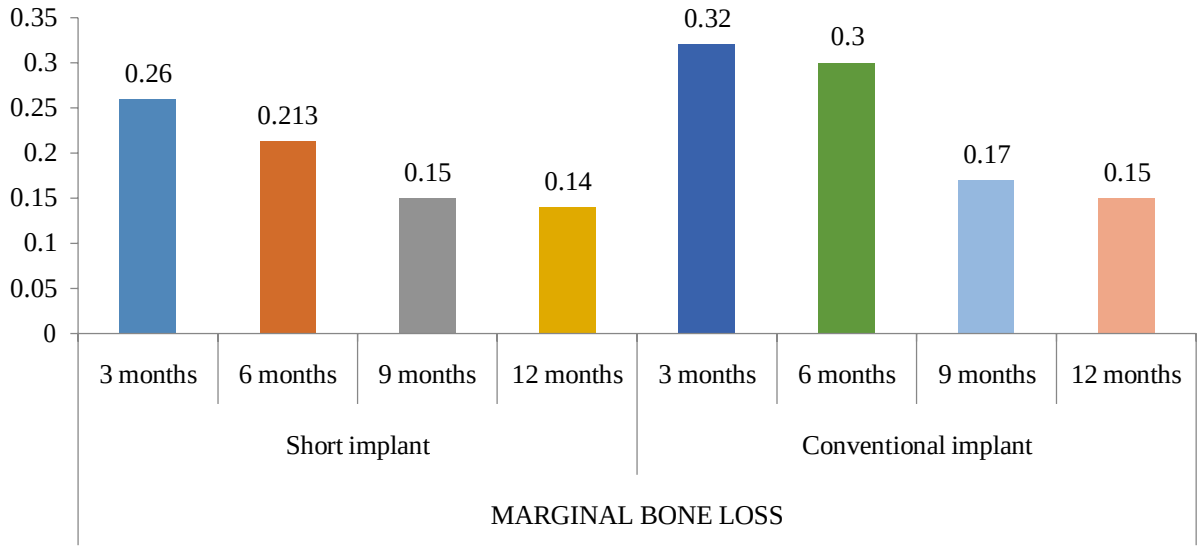
At 9 months follow up, the mean probing pocket depth is found to be 4.81(±0.41) in the short implant group and 4.86(±0.42) in the conventional implant group. The difference of 0.05between the mean values of the two groups is found to be statistically not significant (p = 0.791) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to probing pocket depth at the 9 month follow up period.

At 12 months follow up, the mean probing pocket depth is found to be 4.74(±0.42) in the short implant group and 4.81(±0.45) in the conventional implant group. The difference of 0.07between the mean values of the two groups is found to be statistically not significant (p = 0.723) indicating that, there is no statistically significant difference between short implant and conventional implant with respect to probing pocket depth at the 12 month follow up period. **(Table 4; Graph 4)**

Thus, there is no statistically significant difference between short implants and conventional implants with respect to probing pocket depth at any of the follow up periods.

Table-5: Assessment of changes in Marginal Bone Loss at the follow up periods in Short Implant group and Conventional Implant group

PARAMETERS	PAIRS	SHORT		CONVENTIONAL	
		Mean difference	P value	Mean difference	P value
Marginal Bone Loss	3 months vs 6 months	0.05	0.221, NS	0.02	.678, NS
	3 months vs 9 months	0.11	0.003, S	0.15	.048, S
	3 months vs 12 months	0.12	0.009, S	0.17	.035, S
	6 months vs 9 months	0.06	0.047, S	0.13	.05, S
	6 months vs 12 months	0.07	0.009, S	0.15	.0.43, S
	9 months vs 12 months	0.01	0.758, NS	0.02	.591, NS



Graph-5: Assessment of changes in Marginal Bone Loss at the follow up periodsin Short Implant group and Conventional Implant group

With respect to changes in marginal bone loss at the four follow up periods, in short implant group, the decrease in mean marginal bone loss is found to be statistically significant between 3 months and 9 months (p = 0.003) , between 3 months and 12 months (p = 0.009),between 6 months and 9 months (p = 0.047) and between 6 months and 12 months (p = 0.009). The differences between 3 months and 6 months

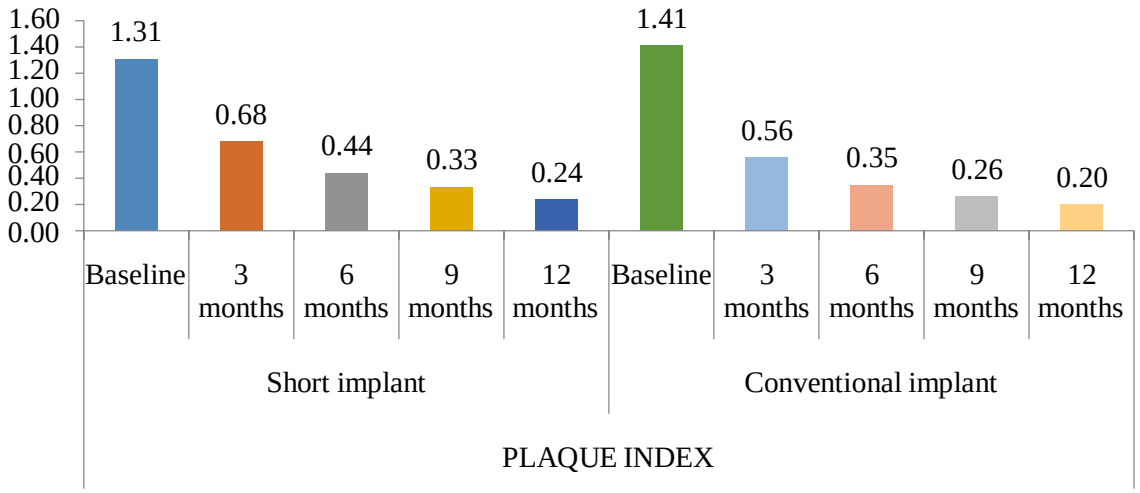
and between 9 months and 12 months are statistically not significant.

In conventional implant also, the differences in mean marginal bone loss is found to be statistically significant between 3 months and 9 months ($p = 0.048$), between 3 months and 12 months ($p = 0.035$), between 6 months and 9 months ($p = 0.05$) and between 6 months and 12 months ($p = 0.043$). The differences between 3 months and 6 months and between 9 months and 12 months are statistically not significant. **(Table 5; Graph 5)**

Thus, with respect to marginal bone loss, the changes in mean values in short implant group and in conventional implant group are found to be similar.

Table-6: Assessment of changes in Modified Plaque Index at the follow up periods in Short Implant group and Conventional Implant group

PARAMETERS	PAIRS	SHORT		CONVENTIONAL	
		Mean difference	P value	Mean difference	P value
mPI	Baseline vs 3 months	0.63	0.001, S	0.85	.001, S
	Baseline vs 6 months	0.87	P < 0.001, HS	1.06	P < 0.001, HS
	Baseline vs 9 months	0.98	P < 0.001, HS	1.15	P < 0.001, HS
	Baseline vs 12 months	1.07	P < 0.001, HS	1.21	P < 0.001, HS
	3 months vs 6 months	0.24	0.001, S	0.21	.001, S
	3 months vs 9 months	0.35	P < 0.001, HS	0.30	P < 0.001, HS
	3 months vs 12 months	0.44	P < 0.001, HS	0.36	P < 0.001, HS
	6 months vs 9 months	0.11	0.007, S	0.09	0.019, S
	6 months vs 12 months	0.20	0.001, S	0.15	0.007, S
	9 months vs 12 months	0.09	0.010, S	0.06	0.024, S



Graph-6: Assessment of changes in Modified Plaque Index at the follow upperiods in Short Implant group and Conventional Implant group

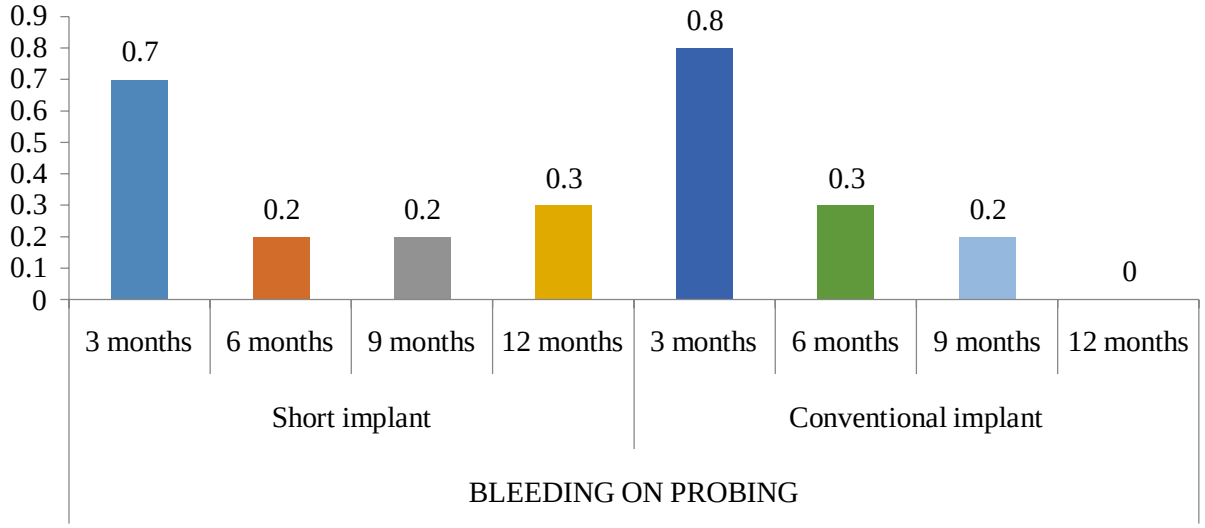
With respect to changes in plaque index the four follow up periods, in short implant group, the decrease in mean plaque index is found to be statistically significant from baseline to 3 months ($p = 0.001$) and highly significant from baseline to6 months, from baseline to 9 months and from baseline to 12 months ($p < 0.001$). Again significant decrease is found from 3 months to 6 months($p = 0.001$) and highly significant decrease from3 months to 9 months and from 3 months to 12 months ($p < 0.001$). Beyond 6 months, the decrease in plaque index is found to be significant from 6 months to 9 months ($p = 0.007$), from 6 months to 12 months ($p = 0.001$) and from 9 months to 12 months ($p= 0.010$).

In conventional implant also, the decrease in mean plaque index is found to be statistically significant from baseline to 3 months ($p = 0.001$) and highly significant from baseline to6 months, from baseline to 9 months and from baseline to 12 months ($p < 0.001$). Again significant decrease is found from 3 months to 6 months($p = 0.001$) and highly significant decrease from3 months to 9 months and from 3 months to 12 months ($p < 0.001$). Beyond 6 months, the decrease in plaque index is found to be significant from 6 months to 9 months ($p = 0.019$), from 6 months to 12 months ($p = 0.007$) and from 9 months to 12 months ($p= 0.024$). **(Table 6; Graph 6)**

Thus with respect to plaque index, the changes in mean values in short implant group and in conventional implant group are found to be similar.

Table-7: Assessment of changes in Modified Gingival Index at the follow up periods in Short Implant group and Conventional Implant group

PARAMETERS	PAIRS	SHORT		CONVENTIONAL	
		Mean difference	P value	Mean difference	P value
mGI	3 months vs 6 months	0.50	0.052, NS	0.50	0.015, S
	3 months vs 9 months	0.50	0.015, S	0.60	0.005, S
	3 months vs 12 months	0.40	0.037, S	0.80	0.001, S
	6 months vs 9 months	0.00	1.00, NS	0.10	0.591, NS
	6 months vs 12 months	-0.10	0.591, NS	0.30	0.081, NS
	9 months vs 12 months	-0.10	0.678, NS	0.20	0.168, NS



Graph-7: Assessment of changes in Modified Gingival Index at the follow upperiods in Short Implant group and Conventional Implant group

With respect to changes in bleeding at the four follow up periods, in short implant group, the decrease in mean score is found to be statistically significant from 3 months to 9 months (p = 0.015) and between 3 months and 12 months (p = 0.037). The differences in mean bleeding scores between the other follow up periods are statistically not significant.

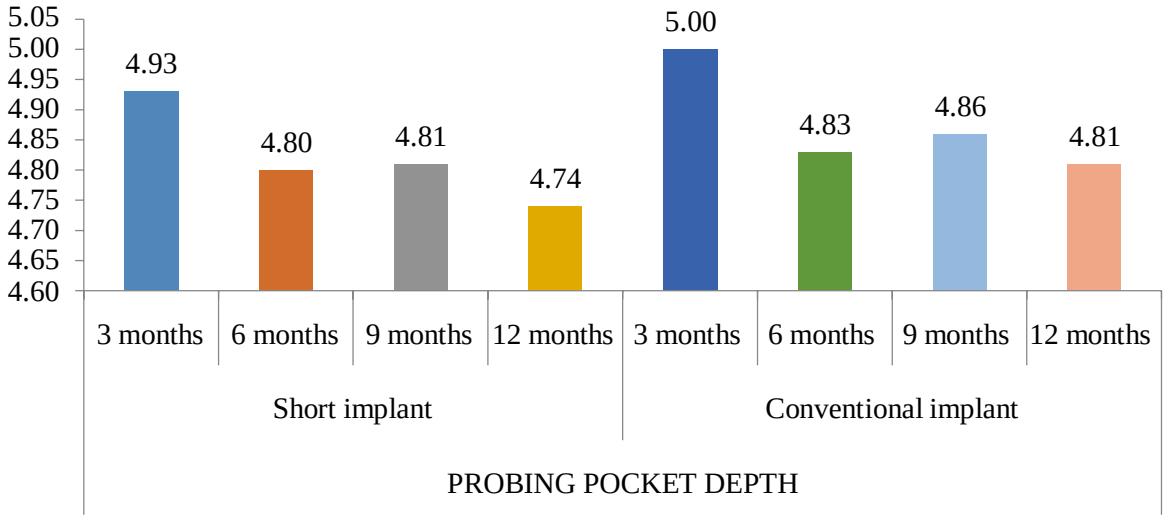
In conventional implant also, the decrease in mean bleeding score is found to be statistically significant from 3 months to 9 months (p = 0.015) and between 3 months

and 12 months ($p = 0.037$). The differences in mean bleeding scores between the other follow up periods are statistically not significant.

Thus, with respect to mGI (bleeding), the changes in mean values in short implant group and in conventional implant group are found to be similar. **(Table 7; Graph 7)**

Table-8: Assessment of changes in Probing Pocket Depth at the follow up periods in Short Implant group and Conventional Implant group

PARAMETERS	PAIRS	SHORT		CONVENTIONAL	
		Mean difference	P value	Mean difference	P value
PPD	3 months vs 6 months	0.13	0.013, S	0.17	0.001, S
	3 months vs 9 months	0.12	0.003, S	0.14	0.013, S
	3 months vs 12 months	0.19	0.001, S	0.19	0.007, S
	6 months vs 9 months	-0.01	0.758, NS	-0.03	0.394, NS
	6 months vs 12 months	0.06	0.081, NS	0.02	0.642, NS
	9 months vs 12 months	0.07	0.10,NS	0.05	0.096, NS



Graph-8: Assessment of changes in Probing Pocket Depth at the follow up periodsin Short Implant group and Conventional Implant group

With respect to changes in probing pocket depth at the four follow up periods, in short implant group, the difference in mean probing pocket depthis found to be statistically significant between 3 months and 6 months (p = 0.013), between 3 months and 9 months (p = 0.003) and between 3 months and 12 months (p = 0.001). The differences in mean probing pocket depth are not statistically significant from 6 months to 9 months (p= 0.758), 6 months to12 months (p = 0.081) and 9 months to 12 months (p =

0.10).

In conventional implant also, the difference in mean probing pocket depthis found to be statistically significant between 3 months and 6 months (p = 0.001), between 3 months and9 months (p = 0.013) and between 3 months and 12 months (p = 0.007). The differences in mean probing pocket depth are not statistically significant from 6 months to 9 months (p= 0.394), 6 months to 12 months (p = 0.642) and 9 months to 12 months (p = 0.096). **(Table 8; Graph 8)**

Thus with respect to probing pocket depth, the changes in mean values in short implant group and in conventional implant group are found to be similar.

DISCUSSION

The objective of this Naïve direct comparison was to analyze and compare the clinical success of single ultra short implants to single conventional ones (data of which taken from past research). Considering the design of present study, heterogeneity at baseline (immediately after loading) for clinical and radiographic parameters may be attributed to the different treatments and population selected.

There is a long-standing conflict in the literature about the definition of short implants. Implant length less than 11, 10, or 8 mm was defined as short implants[11]. In the present study, implants of 5-mm in length were used as short implants. In a systematic review, Lemos et al.(2016) reported that there was no significant difference of implants survival, marginal bone loss (MBL), complications, and prosthesis failures between short implants (8-mm) and conventional implants. Authors conclude that short implants can be considered a predictable treatment options for posterior jaws. However, they also stated that short implants with length <8 mm (4–7 mm) should be used with caution because they present greater risks to failures compared to standard implants[38]. These results are consistent with the recent studies presenting high survival and success rates for short implants[23]. In a prospective 5-year follow-up clinical study of 6-mm implants, a survival rate of 95% was reported[53].Present study reported a 100% survival rate of 10 short implants (5-mm)(somewhat defying the success rates of <8mm short implants) as presented by Lemos et al. (2016) and statistically insignificant ($p \geq 0.05$) difference between the short implants and conventional implants (data from previous studies) over a follow-up period of 12 months. These results were in accordance and even better to previous studies showing a mean survival rate of short implants (8-mm) was 96.13% and that of conventional implant was 97.28%[54].

Considering marginal bone loss (MBL), at 3, 6, 9, 12 months mean MBL for short implants noted as 0.68± 0.18, 0.44 ± 0.13, 0.33 ± 0.17, 0.24 ± 0.12 mm. We have not reported any statistically significant ($p \geq 0.05$) difference in between short implants and conventional implants (from previous studies) which was in accordance with previous data[54]. Certain reports also presented with significantly less MBL in case of short implants compared to standard counterparts. The reason explained by these researchers was the significant effect of wider diameter of short implants[55]. Same can be the reason for less MBL in our study as the diameter of implants selected were 5-

mm (5.0 x 5.0mm). Moreover, in the present study we submerged the short implants 2- mm below the bone crest which may have further reduced the MBL. This was in accordance with previous human prospective comparative study by Chover& Diago et al. 2016, in which they found a mean bone loss of 1.13 mm and 0.57 mm in crestally and sub-crestally placed implants, respectively. They concluded that placing implant sub-crestally increases the amount of bone loss, but the final position of the marginal bone loss remains crestal to implant platform, which is favorable for the peri-implant health[58].

Regarding, post-operative complications, no implant mobility, adverse tissue responses, infections, or unusual patient experiences were noticed. Previous studies presented with higher complication rates of standard implants but it was statistically insignificant comparing with short implants[53]. It is to be noted that most of the standard implants which presented a complicated situation were associated with bone grafting or sinus augmentation procedures for implant installation. Less complications noted in short implant cases may be attributed to the fact that in those situations where an insufficient vertical dimension of bone not allowing a standard implant without bone grafting, a short implant can be placed without many efforts, hence, may simplify healing as seen in present report with 5-mm implant and also becomes a cost effective treatment option. We have evaluated implant mobility by the standard mobility assessment procedure using the blunt end of two mouth mirrors. In the present study we did not used RFA device to assess the mobility due to uni-module design of the *Bicon® Short Implants*.

The effects of crown-to-implant ratio were not evaluated in the present study. Although biomechanical studies have reported that higher crown-to-implant ratio may increase the MBL, this unfavorable effect has not been observed in clinical studies[56]. In a systematic review, Quaranta et al. 2014 reported that the crown-to-implant ratio cannot be considered as a risk factor for biological complications around dental implants and implant failure.

Our secondary objective was to compare soft tissue parameters between two implant systems (short from present study and standard from previous research). These soft tissue parameters represent important elements of implant diagnostics and have been included in the success criteria of implants. However, a recent review reported that

periodontal indices such as mGI, mPI, and PPD are irrelevant diagnostic tools in the evaluation of implants and that these should be avoided, as they cause unnecessary trauma to the peri-implant tissues[57].

In this clinical study, no statistically significant differences were found in terms of soft tissue parameters between short and standard implants (from previous studies). Additionally, our measurements did not traumatize or affect the peri-implant tissues. Comparing these results with existing literature is quite difficult, since most clinical studies do not report soft tissue outcomes.

The short comings of present study were that it is a Naïve direct comparison and there was no control group involving standard implants. We had to take conventional implant data from previous suitable studies. Another important short coming was the small sample size of only 10 short implants which further reduce the power of study. Moreover, crown-to-implant (C/I) ratio and RFA quotient was not considered in the present report as comparison parameters. Hence, we suggest further randomized controlled clinical trials with larger sample size to assess the predictability and stability of the 5.0 x 5.0mm short implants.

CONCLUSION

Based on the observations, statistical analysis, and evidence based discussion, the following conclusion has been drawn;

1. There was no significant difference between short implants and conventional implants with regard to survival rates of implants, marginal bone loss, complications, and prosthesis failures.
2. There was no statistically significant difference in modified Plaque index, modified Gingival Index and Probing pocket depths in both groups.
3. Short dental implants can be used to support single unit restorations in lower jaws.
4. The conventional root form dental implants can only be used in situations when an adequate alveolar bone volume is present, which otherwise would require additional bone grafting /augmentation procedure.

Lack of significant published data and limited number of implants in a limited time period of the study has made the comparison difficult and no significant outcome can be firmly out lined but it is worthwhile to mention that short implants do provide a viable restorative solution to edentulous areas specially in a compromised or insufficient alveolar bone volume areas like posterior mandible. This can be a cost effective treatment option in complex situations but long term follow up with larger number of implants is required to prove its efficacy worthy enough of documentation.

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APPENDICES

ANNEXURE -

BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES
(FACULTY OF BBD UNIVERSITY), LUCKNOW

INSTITUTIONAL RESEARCH COMMITTEE APPROVAL

The project titled **"Assessment of the Success of Short Implants: A Clinical Study."** submitted by **Dr Sangeeta Barman** Post graduate student from the **Department of Periodontology** as part of MDS Curriculum for the academic year 2018-2021 with the accompanying proforma was reviewed by the Institutional Research Committee present on **27th November 2018** at BBDCODS.

The Committee has granted approval on the scientific content of the project. The proposal may now be reviewed by the Institutional Ethics Committee for granting ethical approval.

Prof. Vandana A Pant
Co-Chairperson

Prof. B. Rajkumar
Chairperson

ANNEXURE -

Babu Banarasi Das University
Babu Banarasi Das College of Dental Sciences,
BBD City, Faizabad Road, Lucknow – 226028 (INDIA)

Dr. Lakshmi Bala
Professor and Head Biochemistry and
Member-Secretary, Institutional Ethics Committee

Communication of the Decision of the VIIth Institutional Ethics Sub-Committee

IEC Code: 30 **BBDCODS/01/2019**

Title of the Project: Assessment of the Success of Short Implants: A Clinical Study.

Principal Investigator: Dr. Sangeeta Barman **Department:** Periodontology

Name and Address of the Institution: BBD College of Dental Sciences Lucknow.

Type of Submission: New, MDS Project Protocol

Dear Dr. Sangeeta Barman,

The Institutional Ethics Sub-Committee meeting comprising following four members was held on 10th January 2019.

1.	Dr. Lakshmi Bala Member Secretary	Prof. and Head, Department of Biochemistry, BBDCODS, Lucknow
2.	Dr. Amrit Tandan Member	Prof. & Head, Department of Prosthodontics and Crown & Bridge, BBDCODS, Lucknow
3.	Dr. Rana Pratap Maurya Member	Reader, Department of Orthodontics & Dentofacial Orthopedics, BBDCODS, Lucknow
4.	Dr. Sumalatha M.N. Member	Reader, Department of Oral Medicine & Radiology, BBDCODS, Lucknow

The committee reviewed and discussed your submitted documents of the current MDS Project Protocol in the meeting.
The comments were communicated to PI thereafter it was revised.

Decisions: The committee approved the above protocol from ethics point of view.

Forwarded by:

Lakshmi Bala 21/01/19

(Dr. Lakshmi Bala)
Member-Secretary
IEC

Member-Secretary
Institutional Ethic Committee
BBD College of Dental Sciences
BBD University
Faizabad Road, Lucknow-226028

(Dr. B. Rajkumar)
Principal
BBDCODS

PRINCIPAL
Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow-226028

ANNEXURE -3

Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

सहमति पत्र

अध्ययन शीर्षक.....
अध्ययन संख्या.....
प्रतिभागी के पूर्ण नाम.....
जन्म तिथि / आयु.....
प्रतिभागी का पता .....
फोन नं. और ई-मेल पता .....
योग्यता .....
व्यवसाय: छात्र / स्व कार्यरत / सेवा / ग्रहिणी .....
अन्य (उचित रुप मे टिक करें) .....
प्रतिभागी की वार्षिक आय .....
प्रत्याशीयो के नाम और प्रतिभागी से संबंध...(परीक्षण से संबंधित मौत के मामले मे मुआवजे के प्रयोजन के लिए)

1. मेरी पुष्टि है कि मैने अध्ययन हेतु सुचना पत्र दिनांक ..... को पढ व समझ लिया तथा मुझे प्रश्न पुछने या मुझे अध्ययन अन्वेषक ने सभी तथ्यों को समझा दिया है तथा मुझे प्रश्न पुछने के समान अवसर प्रदान किए गये।

2. मैंने यहॉ समझ लिया कि अध्ययन में मेरी भागीदारी पूर्णतः स्वैच्छिक है और किसी भी दबाव के बिना स्वतंत्र इच्छा के साथ दिया है किसी भी समय किसी भी कारण के बिना , मेरे इलाज या कानूनी अधिकारो को प्रभावित किए बिना , अध्ययन में भाग न लेने के लिए स्वतंत्र हुँ ।

3. मैंने यह समझ लिया है कि अध्ययन के प्रायोजक , प्रायोजक की तरफ से काम करने वाले लोग, आचार समिति और नियामक अधिकारियों को मेरे स्वास्थ्य रिकार्ड को वर्तमान अध्ययन या आगे के अध्ययन के सन्दर्भ देखने के लिए मेरी अनुमति की जरूरत नही है, चाहे मैने इस अध्ययन से नाम वापस ले लिया है। हॉलाकि मै यह समझता हुँ कि मेरी पहचान को किसी भी तीसरे पक्ष या प्रकाशित माध्यम में नही दी जायेगी।

4. मै इससे सहमत हूँ कि कोई भी डेटा या परिणाम जो इस अध्ययन से प्राप्त होता है उसका वैज्ञानिक उद्देश्य (ओं) के उपयोग के लिए मेरी तरफ से कोई प्रतिबंध नही है।
5. भविष्य के अनुसंधान के लिए भंडारित नमूना (ऊतक/रक्त) पर अध्ययन के लिए अपनी सहमति देता हुँ।

हॉ [ ] नही [ ] अनउपयुक्त [ ]

6. मै परीक्षण की अनुमति देता हुँ। मुझे इसके द्वारा यदि कोई परेशानी होती है, इसके बारे में जानकारी दे दी गई है। मैने रोगी जानकारी सूचना पत्र को पढ तथा समझ लिया है।

प्रतिभागी / कानूनी तौर पर स्वीकार्य प्रतिनिधि का हस्ताक्षर (या अंगूठे का निशान.....

हस्ताक्षरकर्ता का नाम..... दिनांक .....अन्वेषक के हस्ताक्षर ..... दिनांक .....

अध्ययन अन्वेषक का नाम .....

गवाह के हस्ताक्षर ..... दिनांक .....गवाह के नाम .....

मैनें पीआईडी और विधिवत भरे सहमति फार्म का एक हस्ताक्षर की नकल प्राप्त की.

प्रतिभागी कानूनी तौर पर प्रतिनिधि का हस्ताक्षर/ अंगूठे का निशान ..... दिनांक.....

Babu Banarasi Das College of Dental Sciences

(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

Consent Form (English)

Title of the Study ……..

Study Number……..
Subject's Full Name…….
Date of Birth/Age ……
Address of the Subject…….
Phone no. and e-mail address……
Qualification ……
Occupation: Student / Self Employed / Service / Housewife/
Other (Please tick as appropriate)
Annual income of the Subject……
Name and of the nominees(s) and his relation to the subject…… (For the purpose of compensation in case of trial related death).

1. I confirm that I have read and understood the Participant Information Document dated ……..for the above study and have had the opportunity to ask questions. **OR** I have been explained the nature of the study by the Investigator and had the opportunity to ask questions.
2. I understand that my participation in the study is voluntary and given with free will without any duress and that I am free to withdraw at any time, without giving any reason and without my medical care or legal rights being affected.
3. I understand that the sponsor of the project, others working on the Sponsor's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. However, I understand that my Identity will not be revealed in any information released to third parties or published.
4. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s).
5. I permit the use of stored sample (tooth/tissue/blood) for future research. **Yes [ ] No [ ] Not Applicable [ ]**
6. I agree to participate in the above study. I have been explained about the complications and side effects, if any, and have fully understood them. I have also read and understood the participant/volunteer's Information document given to me.

Signature (or Thumb impression) of the Subject/Legally Acceptable Representative:……..
Signatory's Name……. Date …….
Signature of the Investigator…… Date……..
Study Investigator's Name..... Date……..
Signature of the witness…… Date……..
Name of the witness……
Received a signed copy of the PID and duly filled consent form
Signature/thumb impression of the subject or legally Date……..

Acceptable representative

ANNEXURE -4

Babu Banarasi Das College of Dental Sciences

(A constituent institution of Babu Banarasi Das University) BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

Participant Information Document (PID)

Study title: **ASSESSMENT OF THE SUCCESS OF SHORT IMPLANTS: A CLINICAL STUDY**

1. **Invitation paragraph**

   You are being invited to take part in a research study, it is therefore important for you to understand why the study is being done and what it will involve. Please take time to read the following information carefully. Ask us for any clarifications or further information. Whether or not you wish to take part is your decision.

2. **What is the purpose of the study?**

   To assess the success of ultra short implants at different time interval

3. **Why have I been chosen?**

   You have been chosen for this study as you are fulfilling the required criteria for this study.

4. **Do I have to take part?**

   Your participation in the research is entirely voluntary. If you do, you will be given this information sheet to keep and will be asked to sign a consent form. During the study you still are free to withdraw at any time and without giving a reason.

5. **What will happen to me if I take part?**

   You will be one of the subjects, enrolled in the study. To assess the success of ultra short implants at different time interval

6. **What do I have to do?**

   You do not have to change your regular lifestyles for the investigation of the study.

7. What is the procedure that is being tested?

The procedure will involve assessing the Marginal bone loss, Modified plaque index, Modified gingival index, Pocket probing depth and Implant mobility at different time interval

8. What are the interventions for the study?

Patient with partial edentulism in mandibular posterior arch and residual bone height between 5-7 mm will be selected for the study

9. What are the side effects of taking part?

There are no side effects on patients of this study.

10. What are the possible disadvantages and risks of taking part?

There are no risks or disadvantages of taking part in this study.

11. What are the possible benefits of taking part?

This study will help us to compare the efficacy of ultra short implants with conventional implant

12. What if new information becomes available?

If additional information becomes available during the course of the research you will be told about these and you are free to discuss it with your researcher, your researcher will tell you whether you want to continue in the study. If you decide to withdraw, your researcher will make arrangements for your withdrawal. If you decide to continue in the study, you may be asked to sign an updated consent form.

13. What happens when the research study stops?

If the study stops/finishes before the stipulated time, this will be explained to the patient/volunteer.

14. What if something goes wrong?

If any severe adverse event occurs, or something goes wrong during the study, the complaints will be handled by reporting to the institution (s), and

Institutional ethical community

15. **Will my taking part in this study be kept confidential?** Yes it will be kept confidential.

16. **What will happen to the results of the research study?**

The results of the study will be to assess marginal bone loss, modified plaque index,modified gingival index, implant mobility, probing pocket depth

17. **Who is organizing theresearch?**

This research study is organized by the academic institution (BBDCODS).

18. **Will the results of the study be made available after study is over?** Yes.

19. **Who has reviewed the study?**

The study has been reviewed and approved by the Head of the Dept, and the IEC/IRC of the institution.

20. **Contact for further information**

Dr Sangeeta Barman
Department of Periodontology
Babu Banarasi College of Dental Sciences.
Lucknow-227105 Mob.8638717387

Dr Vandana A Pant (HOD)
Department of Periodontology
Babu Banarasi College of Dental Sciences.
Lucknow-227105 Mob- 9935957775

Dr. Laxmi Bala, Member Secretary,
Babu Banarasi College of Dental Sciences.
Lucknow
bbdcods.iec
@gmail.com

ANNEXURE -4

FORMULA USED FOR STATISTICAL ANALYSIS

Descriptive statistics tools:

a) Arithmetic means as a measure of central tendency of the data values.

b) Standard Deviation as a measure of dispersion of the data values around the arithmetic mean.

c) Bar Charts to provide a visual representation of the observed statistics.

d) Tables summarizing the observed statistics.

Inferential statistics techniques:

A) Independent Samples _T' test: All comparisons of mean values between the Short and Conventional Implants were tested for statistical significance using Independent Samples t Test at 0.05 significance level. The inferences are drawn with the help of the p value generated by the test. For a p-value which is > or = 0.05, the difference between the means of the two groups would be inferred as **statistically not significant**. For a p-value < 0.05, the difference between the means of the two groups would be inferred as **statistically significant**. A p – value of < 0.001 is considered as **statistically highly significant**.

B) Paired Samples _T' test: All comparisons of mean values between the follow up periods for the two implant groups were tested for statistical significance using Paired Samples T Test at 0.05 significance level. The inferences are drawn with the help of the p value generated by the test. For a p-value which

is > or = 0.05, the difference between the means of the two periods would be inferred as **statistically not significant**. For a p-value < 0.05, the difference between the means of the two periods would be inferred as **statistically significant**. A p – value of < 0.001 is considered as **statistically highly significant**.

All the statistics have been calculated and computed using IBM Statistical Package for Social Sciences (SPSS) version 20 and all diagrams have been prepared using Microsoft Excel.

Sample size $n = \{Z^2_{(1-\alpha)/2} \cdot S^2\} / d^2$

Where n = Required sample size

$Z_{(1-\alpha)/2}$ = Standard normal variate ($\alpha = 0.05$)

S = Estimated standard deviation

d = Absolute error or Desired precision

ARITHMETIC MEAN	$(\sum x) / n$ x- Data values n – Sample size
STANDARD DEVIATION	$\sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$ x- Data values x - Mean n- Sample size
INDEPENDENT SAMPLES T TEST	$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}}$ x_1 = Mean of sample 1 x_2 = Mean of sample 2 s^2_p = Pooled Variance of samples

	n_1 = Size of sample 1 n_2 = Size of sample 2
PAIRED SAMPLES T TEST	$$t = \frac{\overline{X}_D - \mu_o}{s_D/\sqrt{n}}$$ XD = Mean of succeeding period μ0 = Mean of baseline / preceeding periodSD = Standard Error of the difference n = Sample size

ANNEXURE -6

Short Versus Conventional

PARAMETER	FOLLOW UP PERIOD	IMPLANT	Mean	Std. Deviation	Mean difference	P value
Implant Mobility	-	Short	-2.80	2.10	.40	0.736, NS
		Conventional	-3.20	3.05		
Mean Bone Loss	3 months	Short	.26	.14	-.06	0.380, NS
		Conventional	.32	.15		
	6 months	Short	.21	.07	-.03	0567, NS
		Conventional	.24	.13		
	9 months	Short	.15	.11	-.11	0.03, S
		Conventional	.26	.11		
	12 months	Short	.14	.05	-.07	0.167, NS
		Conventional	.21	.14		
Plaque Index	Baseline	Short	1.31	.40	-.10	0.566, NS
		Conventional	1.41	.37		
	3 months	Short	.68	.18	.12	0.132, NS
		Conventional	.56	.16		
	6 months	Short	.44	.13	.09	0.117, NS
		Conventional	.35	.11		
	9 months	Short	.33	.17	.07	0.229, NS
		Conventional	.26	.05		
	12 months	Short	.24	.12	.04	0.361, NS
		Conventional	.20	.07		
Bleeding on Probing	3 months	Short	.40	.52	-.40	0.074, NS
		Conventional	.80	.42		
	6 months	Short	.20	.42	-.10	0.628, NS
		Conventional	.30	.48		
	9 months	Short	.20	.42	.00	1.00, NS
		Conventional	.20	.42		
	12 months	Short	.30	.48	.30	0.065, NS
		Conventional	.00	.00		
Probing Pocket Depth	3 months	Short	4.93	.37	.02	0.908, NS
		Conventional	4.91	.39		
	6 months	Short	4.80	.41	-.03	0.868, NS
		Conventional	4.83	.39		
	9 months	Short	4.81	.41	-.05	0.791, NS
		Conventional	4.86	.42		
	12 months	Short	4.74	.42	-.07	0.723, NS
		Conventional	4.81	.45		

Comparison of parameters at follow up periods

PARAMETERS	PAIRS	SHORT		CONVENTIONAL	
		Mean difference	P value	Mean difference	P value
Mean Bone Loss	3 months vs 6 months	.05	.221, NS	.08	.269, NS
	3 months vs 9 months	.11	.003, S	.06	.360, NS
	3 months vs 12 months	.12	.009, S	.11	.207, NS
	6 months vs 9 months	.06	.047, S	-.02	.726, NS
	6 months vs 12 months	.07	.009, S	.03	.697, NS
	9 months vs 12 months	.01	.758, NS	.05	.369, NS
Plaque Index	Baseline vs 3 months	.63	.000, HS	.85	.000, HS
	Baseline vs 6 months	.87	.000, HS	1.06	.000, HS
	Baseline vs 9 months	.98	.000, HS	1.15	.000, HS
	Baseline vs 12 months	1.07	.000, HS	1.21	.000, HS
	3 months vs 6 months	.24	.001, S	.21	.000, HS
	3 months vs 9 months	.35	.000, HS	.30	.000, HS
	3 months vs 12 months	.44	.000, HS	.36	.000, HS
	6 months vs 9 months	.11	.007, S	.09	.019, S
	6 months vs 12 months	.20	.000, HS	.15	.007, S
	9 months vs 12 months	.09	.010, S	.06	.024, S
Bleeding on probing	3 months vs 6 months	.20	.443, NS	.50	.015, S
	3 months vs 9 months	.20	.168, NS	.60	.005, S
	3 months vs 12 months	.10	.591, NS	.80	.000, HS
	6 months vs 9 months	.00	1.00, NS	.10	.591, NS
	6 months vs 12 months	-.10	.591, NS	.30	.081, NS
	9 months vs 12 months	-.10	.678, NS	.20	.168, NS
Probing Pocket Depth	3 months vs 6 months	.13	.013, S	.08	.087, NS
	3 months vs 9 months	.12	.003, S	.05	.273, NS
	3 months vs 12 months	.19	.001, S	.10	.128, NS
	6 months vs 9 months	-.01	.758, NS	-.03	.394, NS
	6 months vs 12 months	.06	.081, NS	.02	.642, NS
	9 months vs 12 months	.07	.010, S	.05	.096, NS

Curiginal

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