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Original Research

A novel way to place narrow diameter implant using concentrated growth factors(CGF) : An Original research

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ABSTRACT:

Aim: The purpose of the study was to evaluate the effects of CGF application on narrow-diameter implants both clinically and radiographically. Methodology: A total of ten narrow diameter implants coated with CGF were placed in periodontally healthy patients who were above 18 years of age. All the patients were informed about the purpose of study and consent was taken. They were followed up for period of 3 months. Results: Results showed gain in crestal bone levels along with no adverse complications. Conclusion: It as concluded that the use of CGF along with narrow diameter implants is an important adjunct in implantology as it accelerates the soft and hard tissue healing around the implant without performing any extensive surgery in deficient bone width and contributes to the overall success of implants.

Keywords: CGF, Narrow, implants, healing, osseointegration.

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INTRODUCTION

The dental implant is a very successful tool in the treatment of partial and complete edentulism, making it a popular treatment modality. In particular cases of single and multiple tooth loss, preparation of healthy teeth adjacent to the edentulous areas is avoided and the alveolar bone is preserved with implant restorations.[1]

Historically, implants have been used and documented mainly with diameters between 3.75mm & 4.1 mm.[2] The use of a wide or regular - sized implant (>4.0mm) is generally recommended to ensure sufficient bone to implant contact. However, it should be pointed that a minimum of 1mm of bone thickness must surround the entire implant surface, which consequently requires a horizontal crestal alveolar width of 6mm for a standard implant.

In case of bone atrophy of the long - term edentulous areas or bone loss due to periodontal disease, periapical pathologies , and traumatic tooth extractions, bone width is usually not adequate for regular sized implants. In patients with deficient crest width, the utilisation of narrow diameter implants (NDIs), therefore constitutes a technically more simple treatment alternative. Moreover, the use of narrow diameter implant (NDIs) (<3.5mm) in alveolar bone with limited buccolingual and mesio-distal width may prevent the risk of injury to neighbouring teeth.[1]

Osseointegration of dental implants is important for long term success and stability. This process varies from 0-6 months. Various strategies are being explored to shorten this period.[3] Today osseointegration can take place in a much shorter time (6 to 8 weeks) because of modification of titanium surface. The addition of molecules or growth factors to the implant surface is another approach to enhance bone-to-implant contact (BIC).[4]

Another method of accelerating osseointegration is the modulation of healing after the placement of implant. This modulation, in turn can be achieved by bioactive molecules that increase osteoblastic differentiation and accelerate bone healing around the implant.[5]

Growth factors are bioactive proteins which control the process of wound healing. Concentrated growth factors is an advanced 2nd generation platelet concentrate (SACCO in 2006).[6].The autologous fibrin acts as a scaffolding material and as a reservoir to deliver certain growth factors at the site of application.[7] Moreover, it reduces postoperative complications such as pain, inflammation and morbidity.[8]

Thus, Concentrated Growth Factor (CGF) is a biological repairing material, a new generation of blood extract, which stimulates and accelerates the bone formation and healing of tissues.9

Since no study has been conducted with narrow diameter implants and CGF application, therefore, the aim of the present in-vivo study is to evaluate narrow diameter implants placement with CGF both clinically and radiologically.

MATERIALS AND METHODS

An in vivo study was conducted in the Department of Prosthodontics, Crown and Bridge and Oral Implantology, H. P. Government Dental College and Hospital, Shimla, Himachal Pradesh. A total of ten narrow diameter implants coated with CGF were placed in patients based on inclusion and exclusion criteria. All the patients were informed about the purpose of study and after explaining the purpose and nature of study the informed consent form was signed by the patient.

Presurgical assessment

A detailed medical and dental history of each subject was obtained along with preoperative photographs and radiographs. All vital signs were checked and a complete hemogram was done to evaluate the fitness of the patient prior to implant placement. All subjects got there RT-PCR done before the surgical procedure and standard sanitisation for covid was followed.

The surgical area selected for dental implant placement was evaluated clinically for width and to assess for any deep undercuts. CBCT was used to accurately evaluate the amount of bone and proximity from vital structures for each patient. A complete oral prophylaxis along with prescription of 0.2% chlorhexidine gluconate mouth rinse, twice daily for a period of 15 days before dental implant placement was advised. All subjects were motivated to maintain oral hygiene.

Fabrication of Study Models and Surgical Stent:

Preliminary alginate impressions were made and study models fabricated prior to surgery. A diagnostic wax-up of the involved tooth was made and a surgical stent was fabricated based on the wax-up to facilitate implant placement.

Fabrication of the Vinyl Polysiloxane Jig:

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

Procedure for taking IOPA Radiograph:

The periapical radiographs were made with the long cone paralleling technique with radiographic film holders (Rinn XCP) using putty jig for the standardization of the projection & film placement to take radiographs at subsequent visits during the follow-up visits. The subject was seated upright position and the IOPA film was placed in film holder followed by placement in subject's mouth using the putty index. The x-ray tube head was placed against localizing ring of the film holder. The IOPA radiographic unit was set at 70 kV, 7 mA, 0.8 sec and IOPA radiograph taken.

Preparation of Concentrated growth factors [3,5,6,9]

A standard, disposable, 10 ml non-anticoagulant tube was taken and intravenous blood samples from the patient were placed in centrifuge tubes and accelerated for 30s, centrifuged at 2700 rpm for 4 min, 2400 rpm for 4 min, 2700 rpm for 4 min, and 3000 rpm for 3 min, and decelerated for 36 s to stop. All of these acceleration and deceleration processes are adjusted automatically due to the centrifugal device's feature. Three layers were observed in the tube: red blood cell layer at the bottom, platelet-deprived plasma layer (without cell) at the top, and fibrin gel with concentrated growth factor and platelet aggregation in the middle. First, the uppermost platelet-deprived fraction was removed with a sterile syringe. The layer in the form of a membrane containing the concentrated growth membrane was held with the aid of a hemostatic clamp, separated from the red blood cell layer by cutting with a pair of scissors and then pressed to form a membrane.

Placement of Concentrated growth factors

After preparation of CGF clot, it was compressed with piston and serum was collected and transferred to syringe. After

osteotomy site preparation, it was rinsed with serum and gelatinous CGF was placed inside it. Finally implant was placed in osteotomy site.

Implant Placement Procedure:

Crestal incision was given for full thickness flap reflection, to expose the implant site. Surgical stent was then placed over the crest to mark the implant site. The implant site was penetrated with the help of a pilot drill which was used to create a bleeding point and site of initial osteotomy when the surgical stent was still in place. After marking the implant site by surgical stent, the surgical stent was removed and pilot drill was used to complete depth, followed by subsequent drills of increasing diameter to create an osteotomy site of required dimensions for each patient. A paralleling pin was used during osteotomy preparation to assess drill orientation. After the preparation of osteotomy site, it was rinsed with CGF serum obtained during compression of fibrin clot and finally CGF membrane was placed. Implants were then inserted into this osteotomy site with the help of a torque wrench.

Healing abutments were then screwed onto the implants and after thorough irrigation the implant site sutured with non- resorbable 3-0 silk sutures to achieve water-tight closure. The patients were prescribed with antibiotics and analgesics for 1 week, post-operatively.

After 2 months, early loading of implant was carried out.

Impression Making and Prosthesis Fabrication

After abutment placement, the transfer cap was placed on the abutment and the impression was made by polyvinylsiloxane material using indirect impression technique. After applying gingival mask, Impression was then poured in die stone to fabricate the cast. After cast fabrication die preparation was done and wax pattern fabricated. A metal casting was then fabricated from investing and casting of this wax pattern. Metal try in was then made followed by shade selection. Final prosthesis was fabricated and then tried in patient's mouth and occlusion adjusted, after final trial the prosthesis was cemented with the help of Type I Glass Iononer Cement (Luting).

Follow up

Any implant that was removed or failed to osseointegrate was designated as a failed implant. Prosthetic complications such as abutment screw loosening were noted. Patient's perception of pain was evaluated evaluated using a 0 to 10 numbered scale, 0 corresponding to no pain at all, and 10 as the maximum pain imaginable. Patients entire experience with the procedure was also evaluated by a numbered scale after loading. The patient was then recalled for follow up for evaluation which was made at 1 months ,2 month and 3 month of implant placement.

The measurements were recorded at:

1 month following dental implant placement

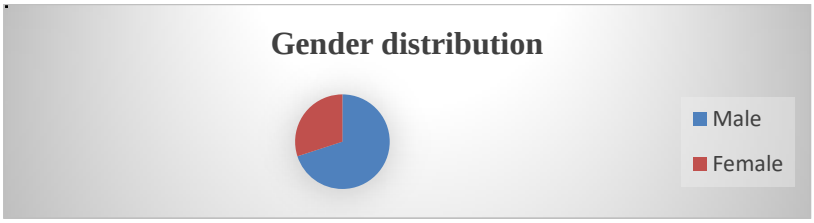
2 month following dental implant placement

3 month following dental implant placement

The standardized periapical radiographs were obtained at immediate post-operative, 1 month, 2 months and 3 months were digitized using Digimizer Image analysis. The known implant length was used to calibrate the images in the computer software. To measure radiologic changes in peri-implant bone level, a fixed reference point had to be selected. The shoulder of the implant was taken as the reference point in the study. The distance from the point to the crest of the bone where it contacted the implant on mesial and distal sides was measured. The first point was selected on the shoulder of the implant. The second point was measured on the crest of the bone where it contacted the bone. The distance between the points was displayed. On each recall the distance was measured and changes in crestal bone levels were analysed.

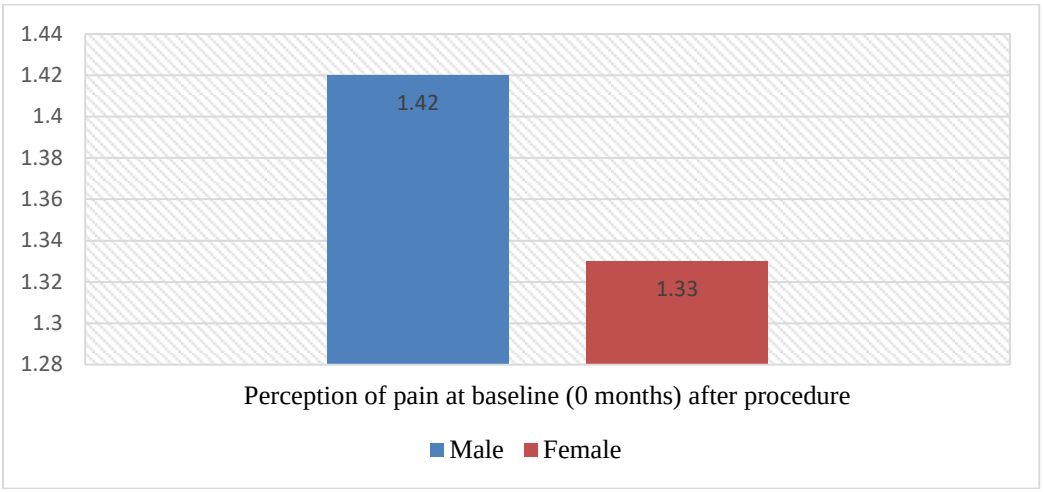
Perimplant area was also checked for radiolucency, if any.

RESULTS

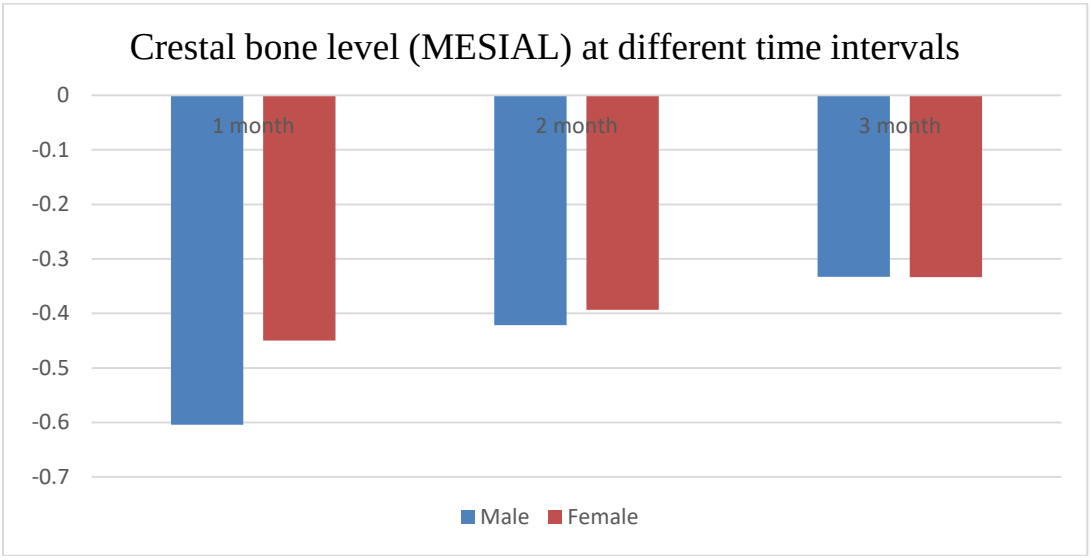


Graph 1: Gender distribution

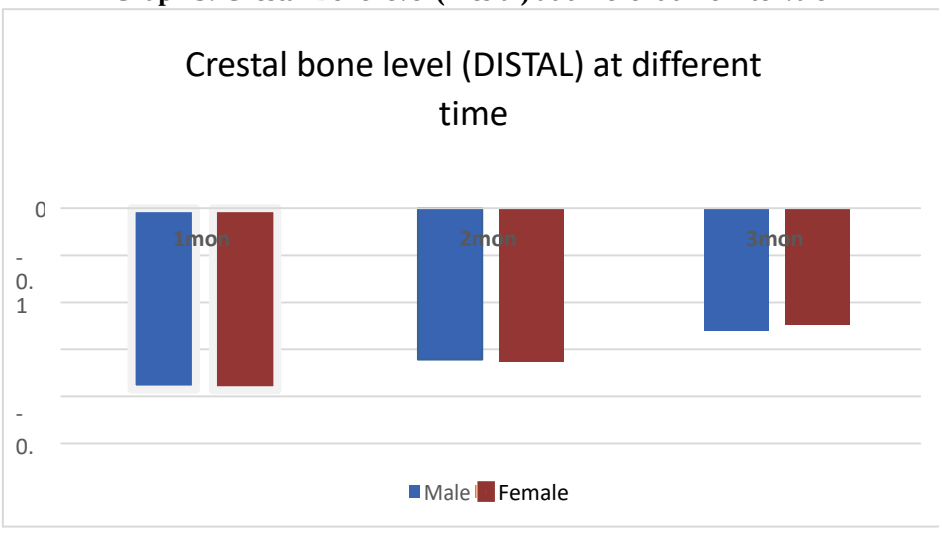
BASED ON GENDER DITRIBUTION



Graph 2: Perception of pain

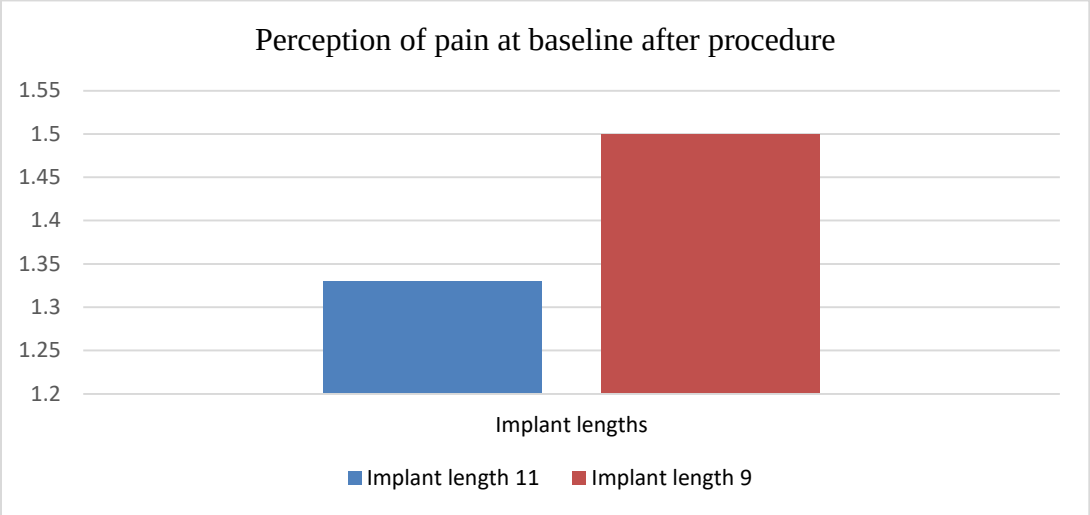


Graph 3: Crestal Bone level (Mesial) at different time intervals

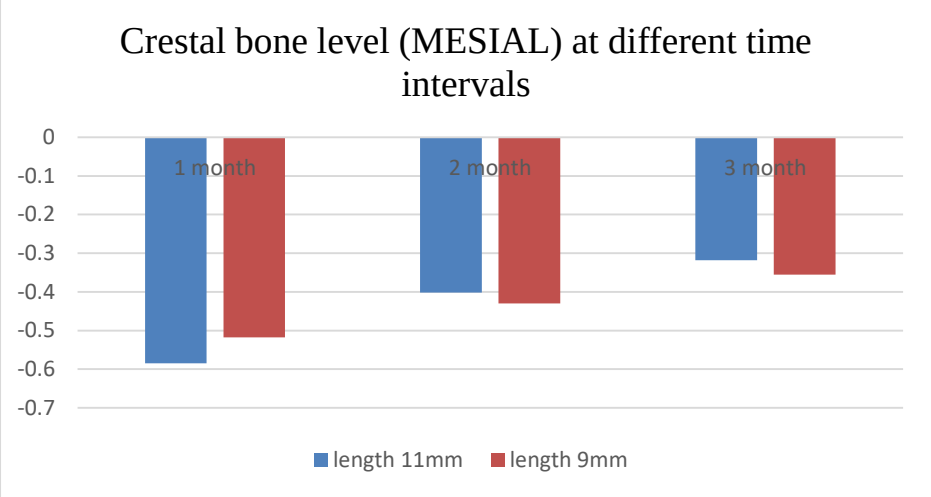


Graph 4: Crestal Bone level(Distal) at different time intervals

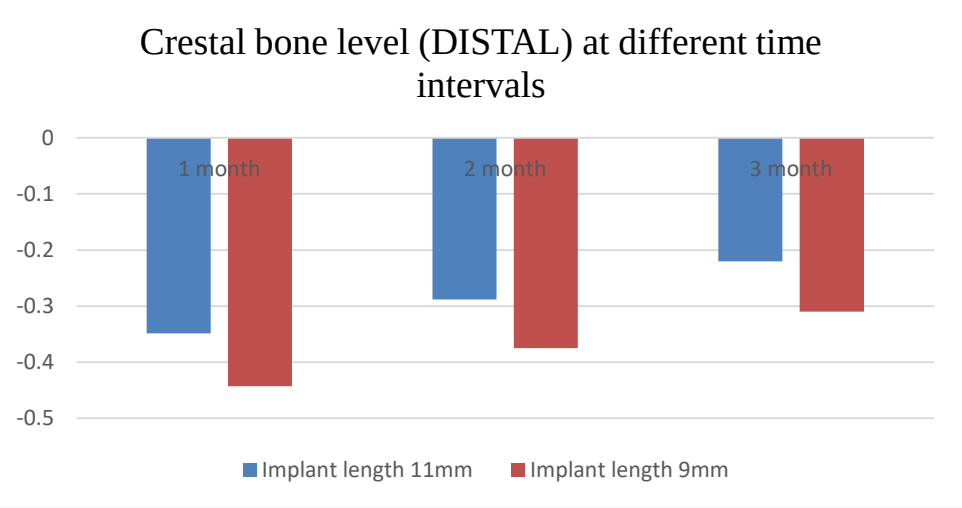
BASED ON IMPLANT LENGTH



Graph 5: Perception of pain

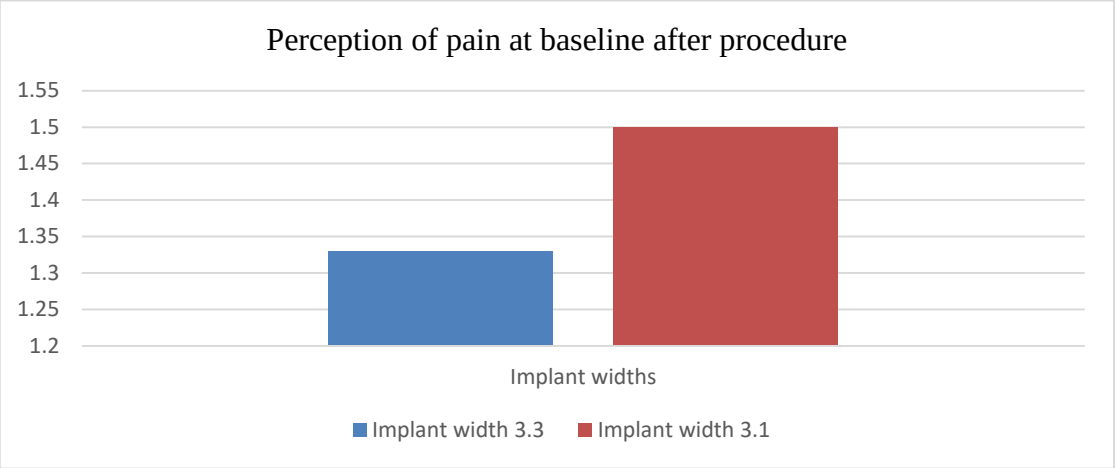


Graph 6: Crestal bone level(Mesial) at different time intervals

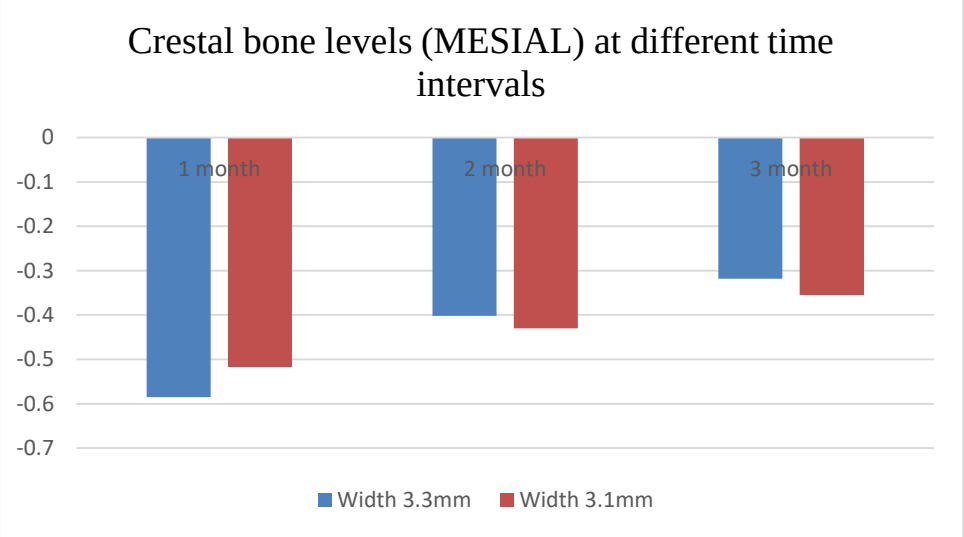


Graph 7: Crestal bone level (Distal) at different time intervals

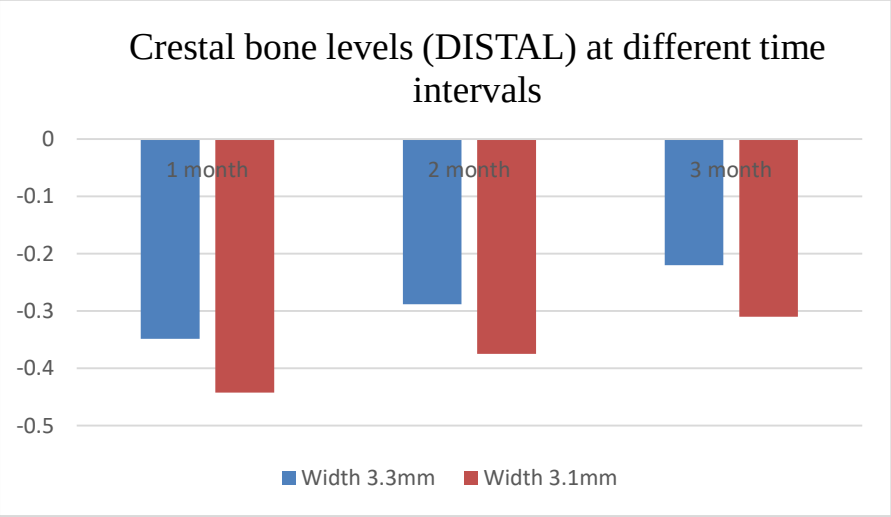
BASED ON IMPLANT WIDTH



Graph 8: Perception of pain



Graph 9: Crestal bone level (Mesial) at different time intervals



Graph 9: Crestal bone level(Distal) at different time intervals

Discussion

The dental implant is a very successful tool in the treatment of partial and complete edentulism, making it a popular treatment modality.[10,11] In particular cases

of single or multiple tooth loss, preparation of healthy teeth adjacent to the edentulous areas is avoided, and the alveolar bone is preserved with implant restorations.[12] The use of a wide or regular-sized implant (≥4.0 mm) is generally recommended to ensure sufficient bone to implant contact.[13-15]

However, it should be pointed out that a minimum of 1 mm of bone thickness must surround the entire implant surface.[16] In cases of bone atrophy of the long-term edentulous areas or bone loss due to periodontal diseases, periapical pathologies, and traumatic tooth extractions, bone width is usually not adequate for regular-sized implants. This is because the width of the buccal and lingual bone walls will be diminished and, in particular, the height of the buccal socket wall will be reduced. Placing a regular-sized implant in such situations may cause large dehiscences, and thus, a risk of complications and failure. Moreover, the use of narrow-diameter implants (NDIs) in alveolar bone with a limited buccolingual or mesiodistal width may prevent the risk of injury to neighboring teeth. To overcome the above mentioned and additional problems related to reduced interdental spaces due to migration or drifting of the remaining teeth, replacement of mandibular incisors and maxillary lateral teeth, and narrow denture-bearing areas in edentulous patients, almost all implant manufacturers have introduced NDIs (diameter ≤3.75 mm).[1]

Osseointegration of dental implants is important for long-term success and stability. There is no standardization in terms of the time of osseointegration and the timing of prosthetic loading. This process varies between 0–6 months.[17] Various strategies are being explored to shorten this period. Changes in implant surface properties and design have increased primer stability and helped the peri-implant tissue remain healthy. These changes have aimed to increase bone-implant surface connectivity and accelerate healing. Another method of accelerating osseointegration is the modulation of healing after the placement of the implant. This modulation, in turn, can be achieved by bioactive molecules that increase osteoblastic differentiation and accelerate bone healing around the implant . Growth factors are bioactive proteins that control the wound healing process. The platelet-containing preparations derived from human blood contain many growth factors such as bone morphogenetic protein (BMP), platelet-derived growth factor (PDGF), insulin-like growth factor (IGF), vascular endothelial growth factor (VEGF), transforming growth factor-β1 (TGF-β1), and transforming growth factor-β2 (TGF-β2), which also play a key role in bone healing. These growth factors attract the undifferentiated mesenchymal cells to the wound site, thus facilitating angiogenesis, chemotaxis, and cell proliferation . Various platelet concentrates such as platelet-rich plasma (PRP), platelet-rich fibrin (PRF), and concentrated growth factor (CGF) are used to reconstruct bone defects . PRF has been shown to have very successful results in tissue engineering in many studies. Furthermore, a study by Sohn et al. has shown the higher regeneration capacity and multipurpose use of CGF in 2009. This preparation's potential is because it contains growth factor-containing fibrin network; it contains fibroblast, platelet, leukocyte, and endothelial cell for angiogenesis and tissue remodeling; and it provides matrix for cell migration. Platelets, in particular, contain biologically active proteins at high concentrations and support healing, growth, and cell morphogenesis.[3] Since the application of CGF reduces osseointegration time**,** thats why early loading was preferred.

Thus the purpose of this study was to evaluate the effects of CGF application on narrow diameter implant both clinically and radiologically. The first aim of this study was to evaluate clinically bleeding on probing after placement of narrow diameter implants with concentrated growth factors.

Results showed mean bleeding on probing 0.0±0.00 at the end of three months. There was no significant difference between1-3 months in all subjects. This can be attributed to the patient motivation for oral hygiene and also individual excellence at it.

CGF preparation's potential is because it contains growth factor-containing fibrin network; it contains fibroblast, platelet, leukocyte, and endothelial cell for angiogenesis and tissue remodeling; and it provides matrix for cell migration.[18] Platelets, in particular, contain biologically active proteins at high concentrations and support healing, growth, and cell morphogenesis.[19-21]

So, platelet aggregates have been widely used to accelerate tissue regeneration and repair in dental and medical fields.[22]

The second aim of the study was to evaluate clinical mobility after placement of narrow diameter implants (NDI's) with CGF.

Results showed zero mobility in all subjects during the follow up periods which indicates towards the

stability of narrow diameter implants coated with CGF.

The results can be attributed to Growth factor-containing products that have shown to accelerate bone healing and osseointegration. Growth factors indicate that they accelerate tissue healing when they function effectively.

Studies in the literature have reported that thrombocytes secrete growth factors from α-granules and that these releasing growth factors promote collagen synthesis. Increased collagen synthesis is thought to play a role in increasing soft tissue resistance and in the initiation of callus formation in bone tissue.

Thrombocytes (platelets) also coexist with other thrombocytes, allowing the fibrin network to remain stable. Within this stable, fibrin clot formation are chemical attractants in surrounding cells such as cell adhesion proteins, thrombocytes, and plasma growth factor; some of these mitogens are related to direct osteogenic cell function.[23]

Pirpir et al. (2017) conducted the study to evaluate effectiveness of concentrated growth factor on osseointegration and found that postoperative ISQ values were 79.40 ±2.604 for the study group and 73.50 ± 5.226 for the control group at 1st week, 78.60 ± 3.136 for the study group and 73.45 ± 5.680 for the control group at 4th week. It was determined that the differences between the groups were statistically significant ($p < 0.05$) and the ISQ measurements at week 1 and week 4 were notably higher in the study group. In the implants in the study group, an increase or stability was observed. A statistically significant difference was found between the study and control groups in each period of analysis hich further suggests that CGF administration affects the implant primary stability by accelerating the osseointegration process.[3]

The third aim of this study was to evaluate patients perception of pain in narrow diameter implants with CGF.

Since all the implants osseointegrated without any uneventful healing, the post-operative follow up showed no such complain by the patient.

Keranmu et al.(2021) studied application of concentrated growth factor to auto-transplantation with infammation in recipient area and concluded that the application of CGF in transplantation area with chronic periapical lesions can accelerate the formation of new bone and the healing of infammation, greatly shorten the healing period. Meanwhile, CGF help to reduce postoperative pain at the early stage of healing and postoperative reaction, and increase the success rate of autogenous tooth transplantation(ATT).[24]

The fourth aim of the study was to evaluate radiographically changes in crestal bone level after placement of narrow diameter implants with CGF.

GENDER BASED: The mean crestal bone level distally at 1 month and 3 month was -0.38±0.09 & -0.26±0.06 respectively in males, which shows significant p value of 0.01 from 1 to 3 months in further follow up period.

LENGTH BASED: The mean crestal bone level mesially at 1 month, 2 month and 3 month was -0.58±0.31, -0.40±0.06 and -0.31±0.04 respectively in group of 11mm implant length placement, which shows significant p value of 0.01 from 2-3 months follow up period.

The mean crestal bone level distally at 1 month and 3 month was -0.34±0.06 and -0.22±0.05 respectively in group of 11 mm implant length placement which shows significant p value of 0.00 from 1 to 3 months along with mean of -0.44±0.07 and -0.31±0.03 in 1 and 3 months respectively which results in significant p value of 0.02 from one to three months of follow up period.

WIDTH BASED: The mean crestal bone level mesially at 1, 2 and 3 months was

-0.58±0.31, -0.40±0.06 and -0.31±0.04 respectively in group of 3.3 mm implant width placement, which shows significant p value of 0.01 from 2 to 3 months follow up period.

The mean crestal bone level distally at 1 and 3 months was -0.44±0.07 and -0.31±0.03 respectively in group of 3.1 mm implant width placement, which shows significant p value of 0.02 from 1 to 3 months follow up period.

Manoj S, Punit J, Chethan H, Nivya J (2018) conducted a study to assess the bone formed around immediate postextraction implants grafted with Concentrated Growth Factor in the mandibular posterior region and concluded that a statistically significant change was noticed in all aspects of bone height when compared immediately and 6 months after implant placement. The findings of this *in vivo* study revealed significant increase in bone volume at the 6 months follow-up. A comparable increase was seen in the density of the new formed bone which was not statically significant. CGF forms richer layers of growth factors and provides an enriched fibrin clot , which has a high cohesion because of the agglutination of fibrinogen, factor XIII, and thrombin, Factor XIIIa, which is activated by thrombin, causes

fibrin to clot. This provides protection from plasmin degradation, resulting in higher fibrin tensile strength and stability.[25]

Nivedhitha Malli Sureshbabu et al (2019) submitted a case report which describes the use of concentrated growth factors (CGF), a new family of autologous platelet concentrates, as a sole material for bone regeneration after periapical surgery and found that there was uneventful healing during the immediate post-op and the subsequent follow-up periods. CGF is produced by a differential centrifugation process that results in the formation of a denser fibrin matrix richer in growth factors than those observed in PRF. Reasonable osseous healing was seen as early as 6-month follow-up, thereby recommending the use of CGF as an alternative to bone grafts and membranes in extensive periapical lesions to enhance bone regeneration and to decrease the healing time.[26]

Hence it can be said that CGF is an optimal substitute for other graft material to maintain the contour and marginal level of the bone and it also helps in regeneration of mature bone in shorter time period. Above studies support the results.

The fifth aim was to find out immediate postoperative complication, if any.

The results show that there was no immediate postoperative complication. This can be attributed the proper surgical protocol followed for the technique. Also due to accelerated healing and anti- infectious properties of PRF.[3,25,26]

Till now no study has been conducted with narrow implants and CGF. The various results show that this study fulfills the success criteria of implant.[15]

All cases were successful; there were no intra-operative and post-operative complications. All implants achieved good osseointegration. These results were obtained by accurately managing the immediate and late postoperative period in all of the treated patients. All patients underwent uneventful implant surgery. All implant were placed according to the surgical protocol, manufacturer's instructions and achieved primary stability. No intra-operative surgical complications were recorded. Particular attention was paid to oral hygiene.

The drawbacks of this study included the fact that in this study:

- The sample size of the study patients is small.
- Long term follow-up is required to thoroughly evaluate the success rate.
- Intra-oral radiography was used to evaluate the radiologic changes in peri-implant bone level, which is quite a sensitive method. However, it should be noted that this technique could only record bone level in two dimensions (mesial and distal). Therefore, it is highly likely that some information (bone loss in the buccal and lingual dimensions) might be missing, although enough data can be recorded for clinical follow up and diagnostic procedures. Currently, new diagnostic radiographic methods such as cone beam computed tomography (CBCT) are more reliable for scientific studies and evaluations, but due to lack of patient co-operation and absence of relevant infrastructure we had to use intraoral radiography.

Although the initial results are promising, there is a further need to evaluate these implants for longer periods.

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