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A study to assess the bone formed around immediate postextraction implants grafted with Concentrated Growth Factor in the mandibular posterior region

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ABSTRACT

Aim Extraction of the teeth and a healing period of 4-6 months followed by implant placement is a common procedure for the treatment of teeth with bad prognosis. This study was done to assess radiographically the quantity and quality of bone formed in the region of mandibular first molar after extraction of the tooth and immediate implant placement with Concentrated Growth Factor (CGF) grafting.

Materials and methods A total of 10 subjects were selected for this prospective study. Extraction of mandibular first molars was carried out and implants were immediately placed with CGF grafting. A Cone Beam Computed Tomography (CBCT) was taken immediately after implant placement and after six months of undisturbed healing, radiographic evaluation was carried out using CBCT to assess the quantity and quality of new bone formed around implants. The collected data were statistically analyzed.

Results CBCT results showed a mean bone gain of 2.3 mm in buccal, 1.52 mm in lingual, 2.97 mm in mesial and 4.26 mm in distal aspect respectively. No statistically significant change was noticed in bone density comparing the first two and last two threads of implants inserted with concomitant placement of CGF into the extraction socket.

Conclusion This study indicates the possibility to perform immediate implant placement in fresh extraction sockets with the use of CGF as an alternative to conventional grafting. Further research needs to be carried out on the subject to validate the results obtained in this study.

KEYWORDS Immediate implant placement, Concentrated Growth Factor.

INTRODUCTION

Various tooth conditions, such as vertical or horizontal root fracture, decay, endodontic or periodontal lesions, if left untreated result in the subsequent loss of the tooth which leads to inefficient oral function and loss of structural balance. For these reasons restoring the lost dentition is imperative. Although traditional fixed partial prosthesis provides a reasonable replacement of the lost tooth, it involves the adjacent healthy tooth as the abutment.

Modern day endosseous implantology is a true stand out in the oral rehabilitation of failing tooth or root fractured teeth in partially edentulous patients. The success rate for implant supported prosthesis documented over the past twenty years is about 94% with a good long term prognosis (1).

In the year 1970 Schulte and Kleineiken Scheidt had introduced the technique of implant placement in freshly extracted socket and it was further modified by Lazzara in 1989 (2).

Immediate implant placement in fresh extraction socket allows placement of implant during the same visit at which the tooth is extracted, which reduces morbidity and decreases treatment time, allows placement of implant in an ideal position from the prosthetic point of view. In 2000, Misch and Judy concluded that the buccal or facial cortical plate loss lost during extraction, leads to reduced bone height and thickness for implant placement after the socket heals (3) Immediate implant placement also helps to preserve the height of the alveolar bone and to avoid marginal bone loss that typically occurs during socket healing after extraction (4, 5). The use of bone regeneration around immediate implants can help to obtain good functional and esthetic outcomes. A 3D radiographic study was done by Lanza et al., demonstrated preserved buccal bone after one year of loading in a case with the use of bone regeneration around immediate implant placement (6).

Hansson et al. in 1983 and Ericsson in 2000 observed

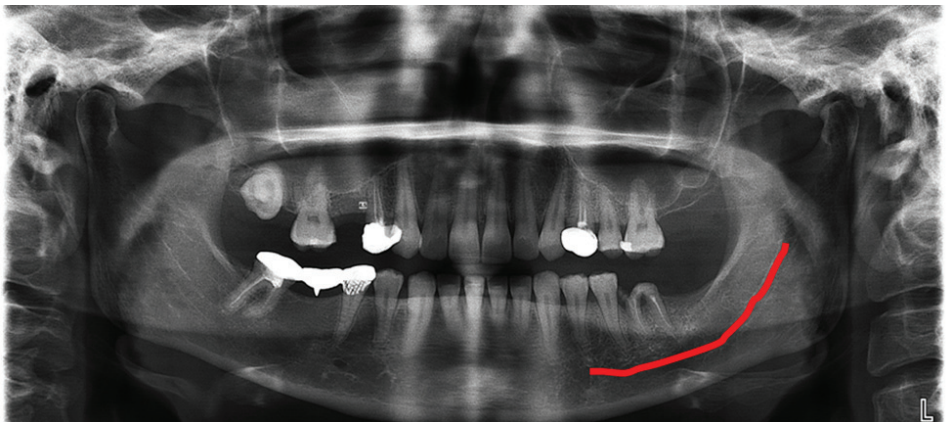

FIG. 1 Preoperative OPG.

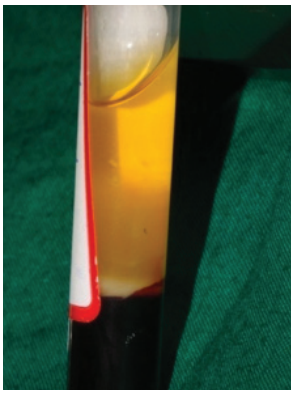

FIG. 2 The blood sample after centrifugation.

that the decreased surgical trauma of immediate placement will decrease the risk of bone necrosis and permit bone remodelling process to occur, that is, the healing period is rapid and allows the woven bone to be transformed into lamellar bone (7, 8). According to Becker et al., when immediate implants were placed within the alveolar boundaries, even without using grafting materials or barrier membrane, high survival rates were reported (9).

To overcome some of the problems associated with the cortical plate loss in immediate extraction placement cases, Concentrated Growth Factor (CGF) was used into fresh extraction sockets concomitantly with immediate implant placement. CGF has shown positive results in socket preservation and implant stabilisation (10, 11). To date no study has investigated the quantity and quality of new bone formation around dental implants inserted in fresh extraction sockets concomitantly with the placement of concentrated growth factor.

MATERIALS AND METHODS

Ten patients from the Department of Prosthodontics, A.B. Shetty Memorial Institute of Dental Sciences, a constituent college of Nitte (deemed to be University), Deralakatte, Mangaluru (India) were selected for this prospective study. Oral examination, blood records and preoperative records were collected for all patients (Fig. 1).

Surgical procedure

Patients were prescribed prophylactic antibiotic therapy (Amoxicillin 500 mg tid) preoperatively and were asked to continue it for 5 further days after surgery.

CGF was prepared according to Sacco's protocol, using the patients' own venous blood (10–20 mL of blood drawn from patients' radial forearm). The venous blood was collected in silica-coated vacutainer tubes without anticoagulant. The blood in the vacutainer tubes was centrifuged using a special centrifuge (Medifuge; Silfradent srl, Sofia, Italy) with a rotor turning at altered and controlled speed (2400–2700 rpm) for 12 minutes. The collected blood was characterized by 3 layers. The uppermost layer was represented by the poor platelet plasma layer (blood plasma without fibrinogen and coagulant). The middle layer was the fibrin buffy coat layer (fibrin blocks containing CGF, white line cells, and stem cells) named CGF. Finally, the lowest red layer represented the red blood cell layer (containing concentrated red and white blood cells, platelets, and clotting factors). The middle layer was used for the procedure presented in this study (Fig. 2).

Induction of local anaesthesia was carried out using 2% lidocaine with 1:80,000 adrenaline (Lignospan special). The tooth was extracted with the help of Coleman straight elevator and cowhorn forceps with the preservation of the buccal bone, with subsequent currettage and antibacterial irrigation (0.12% chlorhexidine gluconate) of the socket. After the preparation of the osteotomy

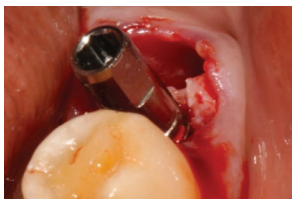

FIG. 3 Implant placement after atraumatic extraction.

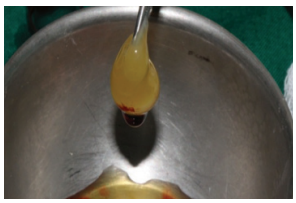

FIG. 4 CGF collection.

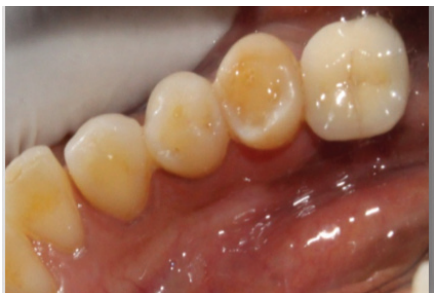

FIG. 5 Cementation of PFM crown of tooth 36.

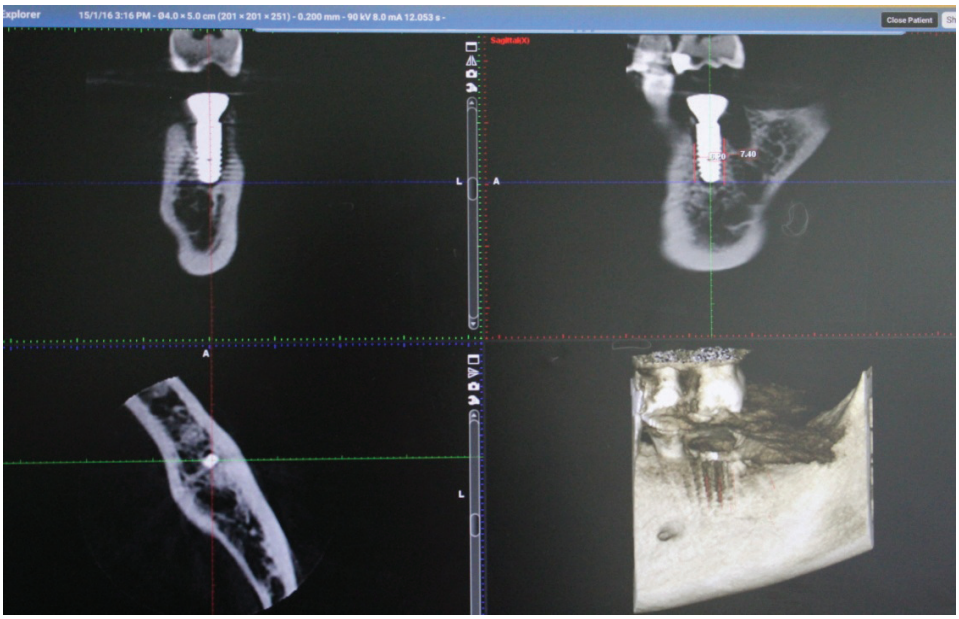

FIG. 6A CBCT immediately after implant placement.

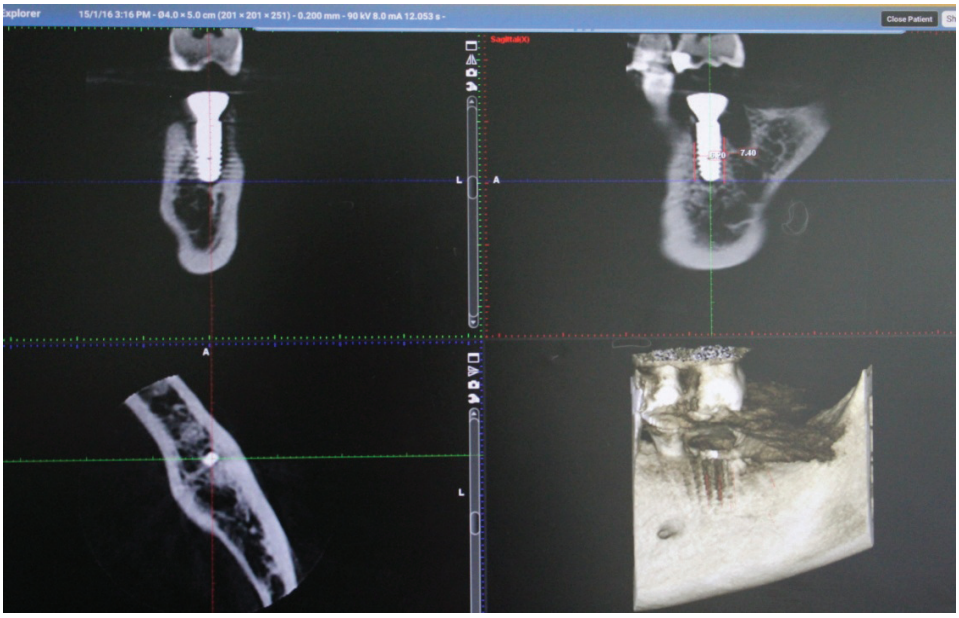

FIG. 6B CBCT 6 months after implant placement.

site, a 3.5 x 11 mm implant (c/x Ankylos) was placed at a minimum insertion torque of 25 Ncm assessed by the physio-dispensor (NSK) (Fig. 3).
CGF was retrieved from the test tube using sterile tweezers and was packed on and around the implant to fill the jumping space (Fig. 4). Following this, a sulcus former of appropriate size was selected and inserted into the implant. The sulcus former was tightened with a 15 Ncm torque, according to the manufacturer's instructions (c/x Ankylos), Vicryl 3-0 sutures were used and intermittent sutures were placed to approximate the incision.

Prosthetic procedure

Six months after implant placement, the sulcus former was removed and a standard abutment was placed and torqued at 25 Ncm; abutment level impression was made using addition silicone material (Aquasil putty and light body, Dentsply). A metal-ceramic crown was cemented using zinc-phosphate cement (De Trey® Zinc) (Fig. 5).

Radiographic analysis

A CBCT was taken immediately (Fig. 6a) and six months after implant placement (Fig. 6b).
The measuring tool in the software was used and a horizontal line was drawn on the most apical part of the implant. A vertical line was drawn from that point till the first bone contact on each buccal, lingual, mesial and distal side for measurement of initial bone status.

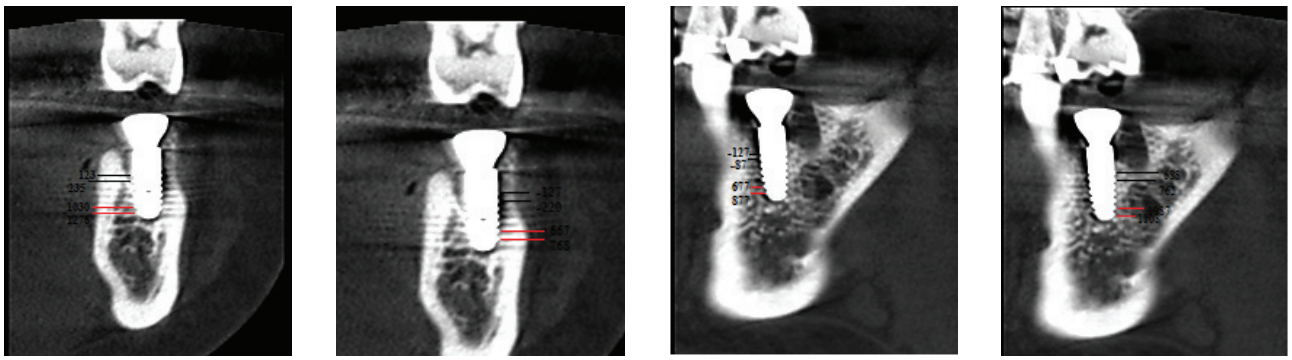

FIG. 7A CBCT analysis of the density of bone around the first two and last two threads of an implant on all the sides, immediately after placement (left to right mesial, distal, buccal and lingual).

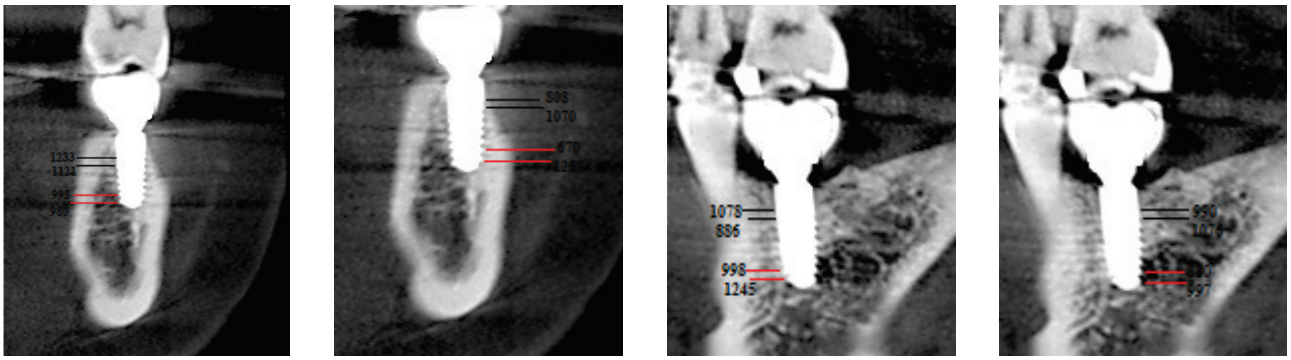

FIG. 7B CBCT analysis of the density of bone around the first two and last two threads of implant on all the sides six months after placement (left to right mesial, distal, buccal and lingual).

A vertical line was drawn from that point till where bone formation was seen above the implant platform on all aspects (buccal, lingual, mesial and distal) and measured in the 6 months post operative CBCT. Also the Hounsfield units was measured adjacent to the first two and last two implant threads. Planmeca Romexis® software version 3.1 was used to evaluate the CBCT scan.

RESULTS

The quantity of new bone formation was measured on the mesial, distal, buccal and lingual surfaces of the implant using Cone Beam Computed Tomography (CBCT). The data collected was entered into Microsoft excel spread sheet and analyzed using IBM SPSS Statistics, Version 22(Armonk, NY: IBM Corp). Descriptive data were presented in the form of mean, median, standard deviation and quartiles. Paired T test was used to compare bone height before and after implant placement. Variation in bone density in the vicinity of implants after 6 months of implant placement was also compared. P value < 0.05 was considered as statistically significant.

In the ten patients treated a total of ten implants were placed. After the six month follow up all the implants were stable and functionally loaded with a 100% survival rate.

Radiographic evaluation of bone formation -

The mean height of bone increased from 8.25 mm to 11.22 mm (mesial), 7.05 mm to 11.31 mm (distal), from 9.09 mm to 11.39 mm (buccal), 10.14 mm to 11.66 mm (lingual) following immediate extraction and implant placement with CGF. The mean bone gain observed was 2.7 mm (mesial), 4.26 mm (distal), 2.3 mm (buccal) and 1.52 mm (lingual) (Table 1). A statistically significant change was noticed in all aspects of bone height when compared immediately and 6 months after implant placement.

CBCT analysis of bone density on the vicinity of the implants (first two crestal and last two apical threads)

CBCT Bone density was analysed at the first two threads crestally and last two threads apically on the mesial, distal, buccal and lingual aspect of the implant immediately after surgery and 6 months after placement (Fig. 7). Comparison of density of the second last thread pre and post, on all sides, showed no significant changes (Table 2). Comparison of density of the last thread pre and post, on all sides, showed no significant changes (Table 3).

Comparison of density of the first thread, pre and post, showed significant changes on the buccal (p=0.006), mesial (p=0.043) and distal sides (p=0.033) (Table 4).
Comparison of density of the second thread, showed significant changes on the buccal (p=0.002) and the distal sides (p=0.001) (Table 5).
The comparison between the average mean density of the first two and last two threads of the implant immediately and 6 months after implant placement showed no significant differences on all sides (Table 6).

DISCUSSION

Immediate implant placement in fresh extraction sockets has several advantages over Branemark's protocol for conventional implant placement. Number of surgical procedures and total treatment time is reduced, better implant positioning is possible, soft tissue height and contour are better preserved in the esthetic anterior zone, chances of osseointegration are better due to the healing potential of the fresh extraction socket (13).
The quality of implant surface dominates wound healing of implantat site and subsequently enhances osseointegration (14). SLA treated implants have increased micro-roughness of the implant surface, thus decreasing the time of osseointegration and increasing the bone-implant contact, when compared to machined implants (15).
In this study 11 mm SLA treated titanium implants

	N	Mean (mm)	Std. Deviation	Paired Differences		t	df	P Value
				Mean Difference	Std. Deviation			
Buccal: immediate post surgery	10	9.09	2.17891	-2.3	2.67706	-2.717	9	**0.024**
Buccal: 6 months post surgery	10	11.39	1.47757					
Lingual: immediate post surgery	10	10.14	1.5233	-1.52	2.05686	-2.337	9	**0.044**
Lingual: 6 months post surgery	10	11.66	1.16733					
Mesial: immediate post surgery	10	8.25	3.09812	-2.97	3.89417	-2.412	9	**0.039**
Mesial: 6 months post surgery	10	11.22	1.41876					
Distal: immediate post surgery	10	7.05	1.75071	-4.26	2.2297	-6.042	9	**<0.001**
Distal: 6 months post surgery	10	11.31	1.00935					
Paired T test P>0.05 non significant								

TABLE 1 Radiographic evaluation of quantity of bone formation following immediate extraction and implant placement.

	N	Mean (mm)	Std. Deviation	Paired Differences		t	df	P Value
				Mean Difference	Std. Deviation			
Buccal: immediate post surgery	10	817.9	541.58	11.5	559.55	0.065	9	0.95
Buccal: 6 months post surgery	10	806.4	337.59					
Lingual: immediate post surgery	10	1403.9	479.21	175.5	501.12	1.107	9	0.297
Lingual: 6 months post surgery	10	1228.4	548.79					
Mesial: immediate post surgery	10	862	374.86	64.8	352.89	0.581	9	0.576
Mesial: 6 months post surgery	10	797.2	262.86					
Distal: immediate post surgery	10	748.9	395.21	-276	520.95	-1.66	9	0.128
Distal: 6 months post surgery	10	1024.9	373.26					
Paired T Test P>0.05 non significant, NS HU- Hounsfield unit								

TABLE 2 comaprison of the pre and post values of apical second last thread of the implant using CBCT.

	N	Mean (mm)	Std. Deviation	Paired Differences		t	df	P Value
				Mean Difference	Std. Deviation			
Buccal: immediate post surgery	10	817.9	541.58	11.5	559.55	0.065	9	0.95
Buccal: 6 months post surgery	10	806.4	337.59					
Lingual: immediate post surgery	10	1403.9	479.21	175.5	501.12	1.107	9	0.297
Lingual: 6 months post surgery	10	1228.4	548.79					
Mesial: immediate post surgery	10	862	374.86	64.8	352.89	0.581	9	0.576
Mesial: 6 months post surgery	10	797.2	262.86					
Distal: immediate post surgery	10	748.9	395.21	-276	520.95	-1.66	9	0.128
Distal: 6 months post surgery	10	1024.9	373.26					
Paired T Test P>0.05 non significant, NS HU- Hounsfield unit								

TABLE 3 comaprison of the pre and post values of apical last thread of the implant using CBCT.

	N	Mean (mm)	Std. Deviation	Paired Differences		t	df	P Value
				Mean Difference	Std. Deviation			
Buccal: immediate post surgery	10	156.7	435.0666	-580.9	516.9768	-3.553	9	**0.006**
Buccal: 6 months post surgery	10	737.6	506.0317					
Lingual: immediate post surgery	10	668.8	709.3482	-295	520.5531	-1.792	9	0.107
Lingual: 6 months post surgery	10	963.8	466.5721					
Mesial: immediate post surgery	10	147.3	661.2186	-475.2	638.6546	-2.353	9	**0.043**
Mesial: 6 months post surgery	10	622.5	468.4685					
Distal: immediate post surgery	10	50.7	234.9648	-552.3	696.3602	-2.508	9	**0.033**
Distal: 6 months post surgery	10	603	567.8474					
Paired T Test P>0.05 non significant, NS HU- Hounsfield unit								

TABLE 4 Comparison of the pre and post values of crestal first thread of the implant using CBCT.

(Ankylos c/x A-11) were used. They are platform switching implants with progressive thread design. The geometry connection (Ankylos Tissue Care) moves the transition between implant and abutment to a central position. This integrated horizontal offset design establishes a broad basis for hard and soft tissue stability at the implant shoulder. In combination with the absence of micro-movement and the prevention from bacterial ingrowth, this enables long-term tissue maintenance.

Interdentally, bone between the root sites is resorbed in the healing process, thus counter-sinking of the implant below the alveolar crest is fundamental (16). In this study implants were counter-sunk 1-2 mm below alveolar crestal bone level to accomplish adequate bone level at the time of second stage surgery.

After immediate implant placement, there is usually a gap between the implant body and the wall of the socket which is known as the jumping distance. A major arguable point is whether it is necessary to graft this distance. According to Becker et al. when immediate implants were placed within the alveolar boundaries, without using graft materials or barrier membrane, high survival rates were reported (17). Carlsson et al. evaluated titanium implants with initial gap width of 0.35 and 0.85 mm and no initial gap. At the end of 6 weeks, the contra lateral group had bone contact reaching 90%, whereas the point 0.35 and 0.85 mm

	N	Mean (mm)	Std. Deviation	Paired Differences		t	df	P Value
				Mean Difference	Std. Deviation			
Buccal: immediate post surgery	10	230.8	435.2616	-801.9	568.5261	-4.46	9	**0.002**
Buccal: 6 months post surgery	10	1032.7	480.509					
Lingual: immediate post surgery	10	652.2	692.2145	-371.8	844.4043	-1.392	9	0.197
Lingual: 6 months post surgery	10	1024	499.7246					
Mesial: immediate post surgery	10	363.7	639.8703	-360.5	662.286	-1.721	9	0.119
Mesial: 6 months post surgery	10	724.2	483.8137					
Distal: immediate post surgery	10	49.3	207.6616	-513.5	347.9135	-4.667	9	**0.001**
Distal: 6 months post surgery	10	562.8	381.5602					
Paired T Test P>0.05 non significant, NS HU- Hounsfield unit								

TABLE 5 Comparison of the pre and post values of crestal second thread of the implant using CBCT.

		N	Mean	Std. Deviation	t	df	P Value
Buccal	Upper two threads	10	835.3	358.4767	-0.27	18	0.79032
	Lower two threads	10	885.15				
Lingual	Upper two threads	10	1253.2	409.4821	1.3047	18	0.208434
	Lower two threads	10	993.9				
Mesial	Upper two threads	10	808.4	260.0881	0.8948	18	0.382696
	Lower two threads	10	673.35				
Distal	Upper two threads	10	900.3	255.3722	1.933	14.212	0.073408
	Lower two threads	10	582.9				
Paired T Test P>0.05 non significant, NS HU- Hounsfield unit							

TABLE 6 Comparison of the bone density at the first two and last two threads of the implant at six months after implant placement using CBCT.

sides had residual gap of 0.23 and 0.55 mm respectively (12).

Wilson et al. in his study placed 5 titanium plasma sprayed implants in one patient, 1 dealt as control in native bone and 4 were placed in fresh extraction sockets. After 6 months of undisturbed implant healing, bone-implant contact in the control group was 72%. In 2 implants placed in extraction sockets with peri-implant bone defects of less than 1.5 mm, the bone-implant contact area was 50%. The other 2 implants were placed where the peri-implant bone defect was more than 4 mm and in conjunction with an e-PTFE membrane, the bone-implant contact was 17%. This study revealed that peri-implant bone defect was the most critical factor in determining bone-implant contact area and membrane was not beneficial in sites with peri-implant bone defect wider than 1.5 mm (18).

While autogenous bone remains the gold standard for grafting, the creation of a 'second' surgical site and the associated morbidity of the donor tissue pose problems at times. As an alternative, allograft and xenografts may be used, which have the risk of cross-infection. Besides the dilemma revolving around the need and choice of graft material to fill the jumping distance, the additional use of a membrane is also a matter of controversy. Various studies have documented some of the complications due to the use of membranes in these sites (19, 20, 21).

The use of CGF has been proposed as a substitute to fill the jumping distance in order to overcome certain disadvantages associated with various graft materials and membranes including increased treatment costs. Concentrated platelets contain many growth factors including: platelet-derived growth factor (PDGF), transforming growth factor b (TGF-b), insulin-like growth factor (IGF), epidermal growth factor (EGF),

fibroblast growth factor (FGF), and bone morphogenetic protein (BMP). BMP facilitates cell proliferation and collagen synthesis, which supports regeneration of bone and cartilage. IGF helps differentiation and stimulates osteogenesis. PDGF and TGF-b are especially known to ameliorate tensile strength and callus formation, with beneficial effects on healing of soft tissue and bone (12, 18).

Numerous methodologies have been suggested which use concentrated platelets containing such growth factors. As a result, CGF has been developed.

CGF, first introduced by Sacco, has recently become popular and is produced by the centrifugation of venous blood as in the case of PRF, but at a different speed (2400-2700 rpm) to separate cells in the venous blood, thus resulting in fibrin rich blocks that are much larger, denser and richer in GF than common PRF. This shows better regenerative capacity and higher versatility when using the fibrin rich block.

According to professor Rodella at the Department of Biomedical Sciences and Biotechnologies of the University of Brescia (Italy), CGF shows higher tensile strength, more growth factors, higher viscosity and higher adhesive strength than PRF. So surgeons can use CGF as barrier membrane to accelerate soft tissue healing or be mixed with bone graft to accelerate new bone formation. CGF does not require any chemical or allergenic additives, such as bovine thrombin or anticoagulants, so it is free from transmission of viral disease. CGF forms richer layers of growth factors and provides an enriched fibrin clot (8), 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 (22).

Due to the above mentioned advantages of CGF we used into fresh extraction sockets after implant placement.

CGF was prepared according to Sacco's protocol, using the patients' own venous blood to accelerate new bone formation in the extraction site after implant placement. The middle layer was the fibrin buffy coat which is the CGF used for this study.

After undisturbed healing of 6 months, a CBCT scan was taken to evaluate the density and the quantity of new bone formed. The findings of the CBCT scan was successful bone formation around the implant in less than 6 months with 100% implant survival rate.

A recent study conducted by Jae-Jin Ahn et al. in 2008 reported that the period for complete bone formation in extraction socket was about 4-5 months and about 7-8 months in the in their control group and disease group respectively.

Our finding by means of CBCT revealed that there was new bone formation. Bone density was also a factor considered between the native bone and the new bone formed using Hounsfield unit's measurement. However, studies have shown that measurement of the density in CBCT is not as accurate as that of a computed tomography (CT) scan (21).

Since the values are compared in the same slice of the scan, a comparison of the densities is possible.

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. 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.

The following are some of the limitation of the study and should be kept in mind when interpreting the result.

- The sample size of the study patients is small.
- Long term follow-up is required to thoroughly evaluate the success rate.
- CBCT scan was used to compare the bone density which is not so accurate as CT scan or histological analysis.

CONCLUSION

Within the limitations of this study, we observed that significant increase in bone volume was evident at 6 months follow-up. A comparable increase was seen in the density of the new formed bone as well. Thus, extraction with immediate placement of implant with CGF grafting can be a reliable alternative that is cost-effective and also asfer, as it would eliminate the common risks that are involved when using other grafting materials.

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