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Evaluation Of Effectiveness Of 0.2% Hyaluronic Acid Gel With Bovine Porous Bone Mineral As Compared To Bovine Porous Bone Mineral Alone In The Treatment Of Intrabony Defects

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Abstract

Background: Bone replacement grafts are widely used to promote bone formation and periodontal regeneration. Bovine porous bone mineral provides a scaffold and a matrix for bone cell migration and are integrated into the natural physiologic remodelling process. Hyaluronic acid [HA] is naturally occurring nonsulphated glycosaminoglycan which stimulates the production of cytokines, keratinocytes, osteoblasts, fibroblast and shares bone induction.

Aim: To evaluate the effectiveness of 0.2% hyaluronic acid gel in combination with Bovine porous bone mineral as compared to Bovine porous bone mineral alone in the treatment of periodontal intrabony defects.

Materials and methods: A total of 20 patients diagnosed as Periodontitis stage III with clinical and radiographic evidence of vertical / angular bone loss ,indicated for regenerative periodontal surgery was randomly assigned. The patients were divided into two groups after Phasle I therapy and treated with 1%Hyaluronic acid gel with Bovine porous bone mineral(BPBM) and Bovine porous bone mineral alone. Clinical parameters such as plaque index(PI), gingival bleeding index(GBI), Probing pocket depth (PPD), and clinical attachment level (CAL) and radiographic analysis were recorded at baseline, 3 months , 6 months and 9 months post operatively.

Results: Significant reduction in the mean probing depth and gain in clinical attachment level was observed in 0.2% hyaluronic acid gel with BPBM and BPBM groups as compared to baseline.

Conclusion: Under the limitations of the study,conclusion can be made that both the groups showed significant favourable clinical and radiographic results.Combination of 0.2% hyaluronic acid gel with BPBM showed favourable results clinically.

Keywords: Intrabony defects, Bovine porous bone mineral, hyaluronic acid gel, periodontal regeneration

Introduction

Periodontitis, an inflammatory disease of supporting tissues of teeth caused by specific microorganism, resulting in progressive destruction of various structures of periodontium[1].One such is osseous defects. The aim of the osseous defect therapy is reconstruction of lost attachment apparatus in conjunction with shallow probing depth(PD), therefore facilitating periodontal maintenance.

Compared to surgical debridement alone there is demonstrable clinical improvement when bone grafts are used in periodontal osseous defects. With respect to treatment of intra bony defect , the results of meta-analysis support the following conclusion. Bone grafts increase bone level ,reduce crestal bone loss ,increase clinical attachment level ,reduce probing pocket depth when compared to open flap debridement procedures[2].Although autogenous bone grafts are considered to be gold standard due to unrestricted availability, avoidance of secondary surgery and decreased surgical time and xenografts are preferred[3].

Purified xenogenic bone mineral matrix (BIO-OSS ,osteohealth) possess good osteoconductive properties,promotes new attachment and bone formation in humans[4,5]. Rabasseda et al reviewed the use of hyaluronic acid for the treatment of inflammatory conditions of knee and TMJ. which led to its use in treatment of periodontal disease[6].It has vital role in the extracellular matrix function,including those of mineralized and non-mineralized periodontal tissues.This study was conducted to evaluate the effectiveness of 0.2% hyaluronic acid gel with bovine porous mineral as compared to bovine porous mineral alone in the treatment of intrabony defect[7].

Materials And Methods

A delineated randomized, controlled clinical trial was formulated. A total of 20 patients were selected from the outpatient sections of the Department of Periodontics after obtaining the approval from institutional ethical board.An informed consent is obtained from the patients after explaining the study design in their own vernacular language.

Systemically healthy patients with stage III periodontitis aged 20 to 50 years with a probing depth ≥ 5mm following Phase-I therapy and with a radiographic evidence of vertical / angular bone loss. Patients are informed about the usage of bovine graft and those who are willing for Bovine graft usage are included in the study. The following patients were excluded in the study: patients showing poor oral hygiene maintenance after Phase-I therapy, patients using tobacco or tobacco related products and pregnant / lactating women

20 intrabony defect sites in stage III periodontitis patients were randomly alloted into two groups, based on the type of treatment modality rendered. Group A(study group) 10 defects treated with Open flap debridement (OFD) ,0.2 %Hyaluronic acid gel with Bovine porous bone mineral(BPBM) and Group B(control group) 10 defects treated with Open flap debridement (OFD) and bovine porous bone mineral.

Upcoming parameters were recorded at baseline, 3 ,6 and 9 months by the same examiner. Plaque index(PI)(Silness and Loe 1967), Gingival Bleeding Index(GBI)(Ainamo& Bay 1975), Probing Pocket Depth(PPD), Clinical Attachment Level(CAL) and intraoral periapical radiograph evaluation. All radiographs were digitalized using digital camera and transferred to the computer as JPEG image.ImageJ software designed for image analysis by National Institute of Health(NIH) was used to analyse radiographic defect .

Surgical procedure

Intra-oral antisepsis and extra-oral antisepsis were performed with 0.2% chlorhexidine digluconate rinse and 5% povidone iodine solution respectively.The surgical site was anaesthetized with 2% Lignocaine HCl with adrenaline (1:80,000) using block or infiltration techniques. Then crevicular incisions were made using Bard Parker blade No.15 on the facial and lingual/palatal surfaces, extending to one tooth on either side of the defect.

A full thickness mucoperiosteal flap was reflected using the periosteal elevator. After flap reflection and exposure of the osseous defect, a thorough debridement of soft and hard tissue was done using the area specific Gracey curettes. Debridement was followed by copious irrigation with 0.9% normal saline. Presuturing was done prior to placement of bone graft.

In Group A the osseous defects were filled with 0.2 % hyaluronic acid gel mixed with bovine porous bone and filled with light pressure(Fig – 2,3).

In Group B defects BPBM was placed into the osseous defect with light pressure and filled upto the most coronal level of osseous defect(Fig – 5,6).The mucoperiosteal flaps were repositioned and secured using 3-0 resorbable suture. Periodontal dressing (Coe-pacTM) was placed.

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Suitable antibiotics and analgesics were prescribed.Patient were instructed to continue regular home oral hygiene care, except in the operated area, in which toothbrushing was refrained for 14 days after surgery and plaque control was maintained by means of gentle topical applications of cotton swabs saturated with 0.12% chlorhexidine gluconate twice a day. Gentle toothbrushing with an extra soft-bristle toothbrush (postsurgical toothbrush) using Charter's method was then initiated after 14 days.

Radiographic Evaluation

Radiographs are taken with radiographic grid using XCP holders and by long cone paralleling technique(Fig 1).The site was radiographically evaluated at baseline, 3rd ,6th and 9th month(Fig 4,7).The following anatomical landmarks of the intrabony defect were identified on the radiograph images based on the criteria set by Bjorn et al[8] and by Schei et al [9]: CEJ(Cemento-enamel junction of the tooth with the intrabony defect),AC(The most coronal position of the alveolar bone crest of the intrabony defect when it touches the root surface of the adjacent tooth before treatment. [The top of the crest]),BD(The most apical extension of the intrabony defect where the periodontal ligament space still retained its normal width before treatment. [The bottom of the defect]).If restorations were present, the apical margin of the restoration was used to replace the CEJ as a fixed reference point.

The following linear measurements were made[10,11]

1. CEJ to bottom of the defect (CEJ to BD) = Defect Depth (DD)
2. CEJ to most coronal extent of the alveolar crest (CEJ to AC)
3. Depth of the intrabony defect at baseline = (CEJ to BD) - (CEJ to AC)
4. CORRECTION FACTOR (CF): In order to estimate distortion between the consequent radiographs, an anatomically non-variable distance i.e., the root length [distance from the CEJ to the root apex (CEJ to RA)] was measured on all the radiographs. The correction factor (CF) was calculated as follows[11]

Correction Factor = CEJ to RA (baseline) / CEJ to RA (post-op)

In cases where it was not possible to measure the root length, the crown length was measured. (Distance from the cusp tip to the CEJ).

5. Bone fill (BF) = CEJ to BD (baseline) - [CEJ to BD (post op) x CF]
6. Bone fill percentage (BF %) = Bone fill x 100/ [Defect Depth (at baseline)]
7. Bone crest change (BCC) = CEJ to AC (baseline) - [CEJ to AC (post op) x CF]
8. Bone crest change percentage (BCC%) = Bone Crest Change x 100/ [CEJ to AC(baseline)].If the results were negative, this means that a process of bone resorption had occurred.[11]
9. Amount of original defect resolution (DR) = Bone fill (BF) - bone crest change (BCC)
10. Percentage (%) of original defect resolution (DR%) = Defect Resolution x 100 / [Depth of intrabony defect (BL)]

All the above mentioned observations were recorded and subjected to statistical analysis.

Statistical Analysis

Descriptive and Inferential statistics were analysed by IBM SPSS version 20.0 (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp). Quantitative data was represented as Mean and SD (PI, GBI, PPD, CAL, Bone fill, Bone Crestal change, Defect resolution).

Independent samples t- test was used for inter-group comparison (Difference in clinical parameters between 2 study groups).

Repeated Measures ANOVA was used for Intra-group comparison (assessment of significance in change in clinical and radiological parameters over study period). Throughout the study a P value of <0.05 was considered as statistically significant difference.

Results

All patients showed good compliance and healing period was uneventful for both the groups, without any signs of infections and complications, indicating biocompatibility of both grafting modalities. The mean PI, GBI ,PPD,CAL scores of both the groups at baseline, 3, 6 and 9 months are shown in Table 1.

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The intragroup and intergroup mean difference in PI, GBI between two groups decreased significantly.Relative PPD decreased in both the groups. On intragroup comparison the mean reduction in PPD for Group A from baseline to 3 months was 3.9±1.6, from 3rd to 6th month was 1.2±0.91, from 6th to 9th month was 0.20±0.63 and was statistically significant p=0.001.For Group B from baseline to 3 months was 3.0±1.2, from 3rd to 6th month was 1.2±0.42, from 6th to 9th month was 0.4±0.51 and was statistically significant p=0.001. On intergroup comparison the mean difference in PPD between Group A and Group B at baseline was p=0.87 and at 3rd, 6th and 9th month was p=0.003,p=0.014 and p=0.049 respectively which was statistically significant.

The mean clinical attachment level has improved in both the groups. On intragroup comparison the mean reduction in CAL for Group A from baseline to 3rd `month was 3.2±0.63 and from 3rd to 6th month was 1.8±1.5 and from 6th to 9th month was 0.20±0.42 with p=0.001 which was statistically significant. For Group B the mean reduction in clinical attachment level from baseline to 3rd `month was 3.0±1.2 and from 3rd to 6th month was 1.1±0.56 and from 6th to 9th month was 0.30±0.67 with p=0.001 which was statistically significant. On intergroup comparison the mean difference in CAL between Group A and Group B at baseline was p=0.87 and at 3 months p=0.86 which was not significant while 6th and 9th month p=0.040 and p=0.024 respectively which was statistically significant.

The mean bone fill, bone fill percentage, bone crest change, bone crest change percentage defect resolution , defect resolution percentage scores of both the groups at baseline, 3, 6 and 9 months are shown in Table 2.

The mean bone fill percentage in both the groups increased. On intragroup comparison of group A(Table 3 & 4) the mean difference in BF % from 3rd to 6th month was -11.90 ±10.5 and from 6th to 9th month was -14.3±16.09 which was statistically significant (p = 0.007). For group B the mean difference in BF % from 3rd to 6th month was -6.20 ±5.4 and from 6th to 9th month was -10.63±6.3 which was statistically significant (p = 0.007). On intergroup comparison the mean difference in BF % between Group A and Group B at 3 months was not statistically significant p=0.32 , At 6th and 9th month the mean difference between group A and group B was statistically significant(p=0.008 and 0.024) respectively.

On intragroup comparison of group A the mean difference in bone crest change(BCC%) percentage from 3rd to 6th month was 14.10 ±11.66 and from 6th to 9th month was -16.10± 7.76which was statistically significant p=0.001.For group B the mean difference in BCC% from 3rd to 6th month was -3.60 ± 10.80 and from 6th to 9th month was -12.40 ± 6.78 which was statistically significant p = 0.001. On intergroup comparison the mean difference in BCC% between Group A and Group B at 3 months was p=0.30 which was statistically not significant. At 6th and 9th month it was statistically significant with p=0.001 and p=0.002 respectively.

On intragroup comparison of defect resolution percentage (DR%) in group A the mean difference in bone fill from 3rd to 6th month was 26±7.2 and from 6th to 9th month was 4.6±6.4 which was statistically significant p =0.022. In group B DR% from 3rd to 6th month was -43.76±10.01 and 6th to 9th month was -11.10±23.65 which was statistically significant p = 0.005. On intergroup comparison the mean difference in DR% at 3rd, 6th and 9th months were statistically significant (p=0.069 p=0.001, p=0.024 respectively).

Discussion

From the above mentioned results there was a substantial reduction in PPD, CAL with a significant bone fill and BCC% in both the groups. However, comparing to Group B, Group A had slightly better significance in clinical parameters and almost same results for radiographic evaluation. This may be attributed to various factors such as defect depth[12], patient compliance and the sample size. This indicates that 0.2 % hyaluronic acid gel mixed with bovine porous bone may have an improved potential for periodontal soft and hard tissue reconstruction.

The results for the group B was similar to the study by Sculean A et al 2004 evaluated the healing of human intrabony defects following treatment with either a bovine derived xenograft (BDX) and guided tissue regeneration (GTR) (BDX+GTR) or a bovine derived xenograft mixed with collagen (BDX Coll) and GTR [BDX Coll + GTR]. The findings of this study indicated that treatment of intrabony defects

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with both BDX+GTR and BDX Coll + GTR , may enhance periodontal regeneration in humans[13].Ballini A et al used Hyaloss® matrix (ester of hyaluronic acid with benzyl alcohol (HYAFF™) for the correction of infrabony defects and it was concluded that autologous bone combined with Hyaloss® has good capabilities in accelerating new bone formation in the infra-bone defects [14].

Sandhu GK et al reported the regenerative capacity of HA gel (Gengigel®) in conjunction with PRF in a patient with Grade II furcation defect, through surgical re-entry after 6months[15].Fawzy El-Sayed et al evaluated the effect of local application of 0.8% Hyaluronan gel in conjunction with periodontal surgery and noted statistically significant differences in clinical attachment level ($P < 0.05$) in favour of the test sites though non-significant results were obtained regarding probing depth[16].

A wide array of new materials has been used for promoting periodontal regeneration in intraosseous defects. The bone replacement grafts provide regeneration through conductive or inductive processes and in combination with growth factors, have the potential to optimize the outcome of periodontal regeneration[17]. Bio-Oss (Geistlich Pharma AG, Wolhusen, Switzerland) is a bovine bone widely used as dental xenograft material that can result in pocket reduction, attachment gain and bone fill in periodontal defects to the same extent as that achieved with demineralized freeze-dried bone[18]. Histologic analysis revealed the presence of significant new cementum with perpendicular inserting collagen fibers and adjacent new bone.But there was inadequate density of the new bone was especially prominent at the coronal aspect of the intrabony lesion[19].

Hyaluronic acid causes elevation in pro-inflammatory cytokine production by inflammatory cells and extracellular matrix cells in initial stages, it also helps in the organization and stabilization of granulation tissue matrix[20].It scavenges reactive oxygen species, such as superoxide radical and hydroxyl radical thus preventing periodontal destruction. Helps in reconstruction of the damaged tissue by migration, proliferation and differentiation of mesenchymal and basal keratinocytes. It has bacteriostatic action[21], promotes angiogenesis, shares bone induction characteristics with osteogenic substances such as BMP-2 and osteopontin.It also acts as a biomaterial scaffold for other materials, such as BMP-2 AND PDGF used in guided bone regeneration techniques and tissue engineering[22,23].

Conclusion

Though the study shows good results clinically and radiographically, surgical re-entry is considered as 'gold standard' in determining the exact type of tissue healing, histological formation of various factors such as new cellular cementum, new periodontal ligament, new bone. Due to ethical consideration re-entry was not done in this study. Thus long term study with clinical and histological evaluation must be in for evaluation of efficacy of BPBM with 0.2% hyaluronic acid in intrabony defects.Nevertheless,the combination of BPBM with 0.2% hyaluronic acid may be considered as good adjunct in regenerative techniques for intrabony defects.

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Figure Legends

Figure 1 – Armamentarium

Figure 2 – Group A preoperative and postoperative clinical photographs

Figure 3 - Group A intraoperative photograph

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Figure 4 - Group A preoperative and postoperative radiographic photographs

Figure 5 – Group B preoperative and postoperative clinical photographs

Figure 6 - Group B intraoperative photograph

Figure 7- Group B preoperative and postoperative radiographic photographs

Table Legends

Table 1 - Master chart - Clinical parameters

Table 2 - Master chart - Radiographical parameters

Table 3 - Intragroup comparison group A clinical and radiographic parameters

Table 4 - - Intragroup comparison group B clinical and radiographic parameters

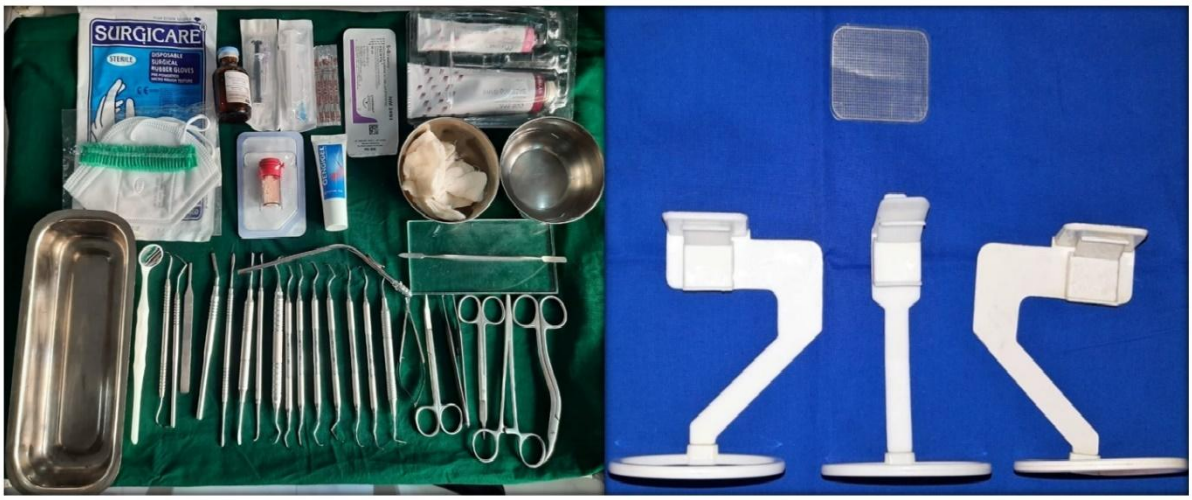

Fig:1- Armamentarium

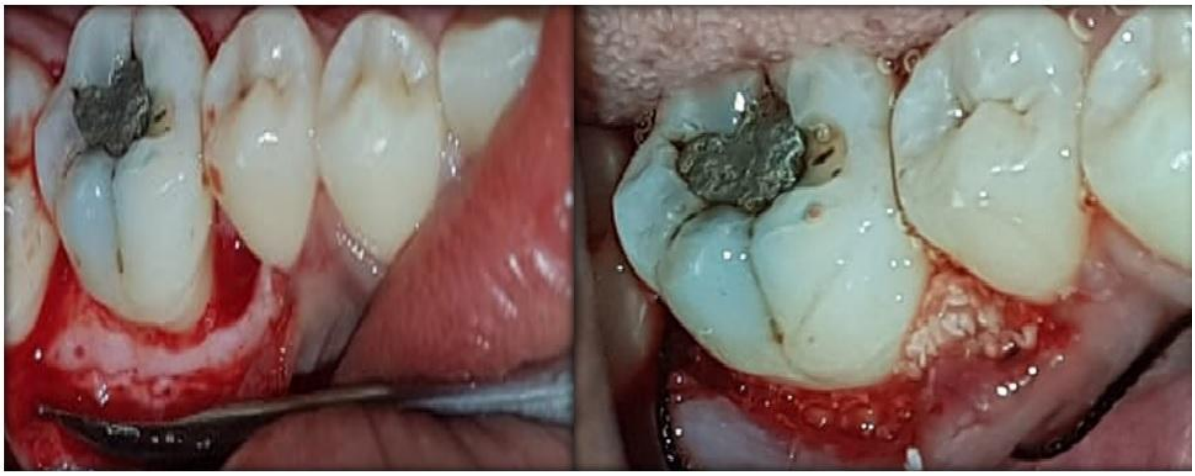

Fig :3 - Group A, A - Intrabony defect exposure, B-Placement of 0.2% hyaluronic acid gel+ bio-oss mixture

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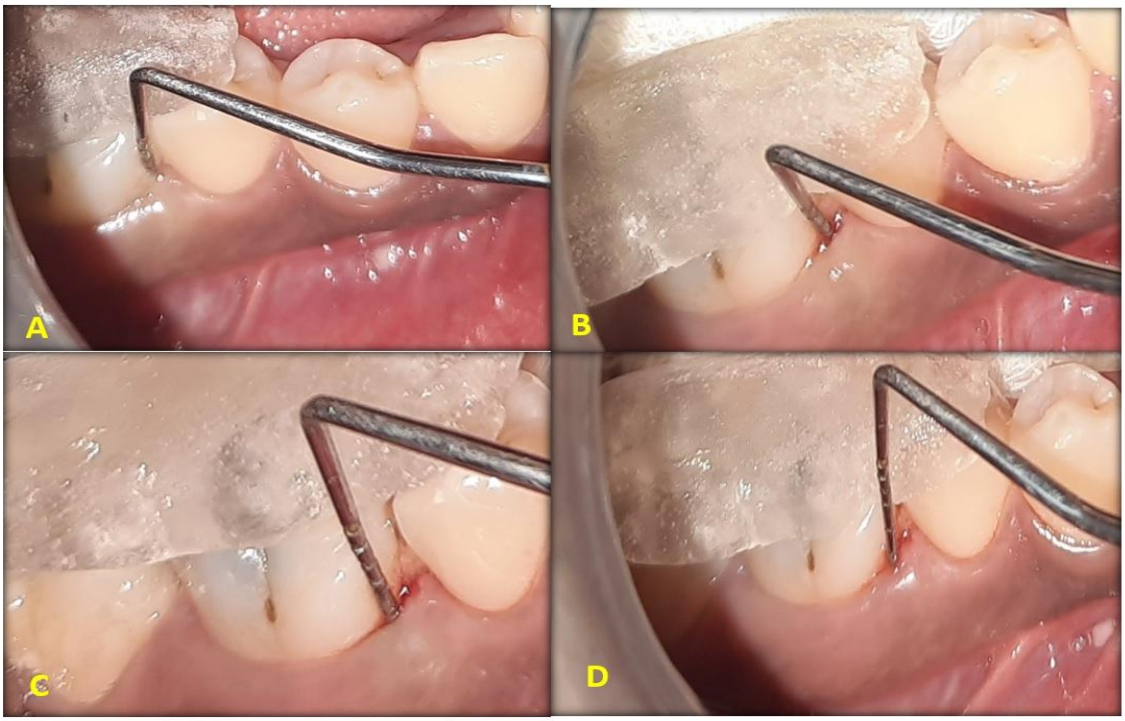

Fig : 2 - Group A, A - Preoperative ,B - 3 months postoperative, C - 6 months postoperative , D- 9 months postoperative

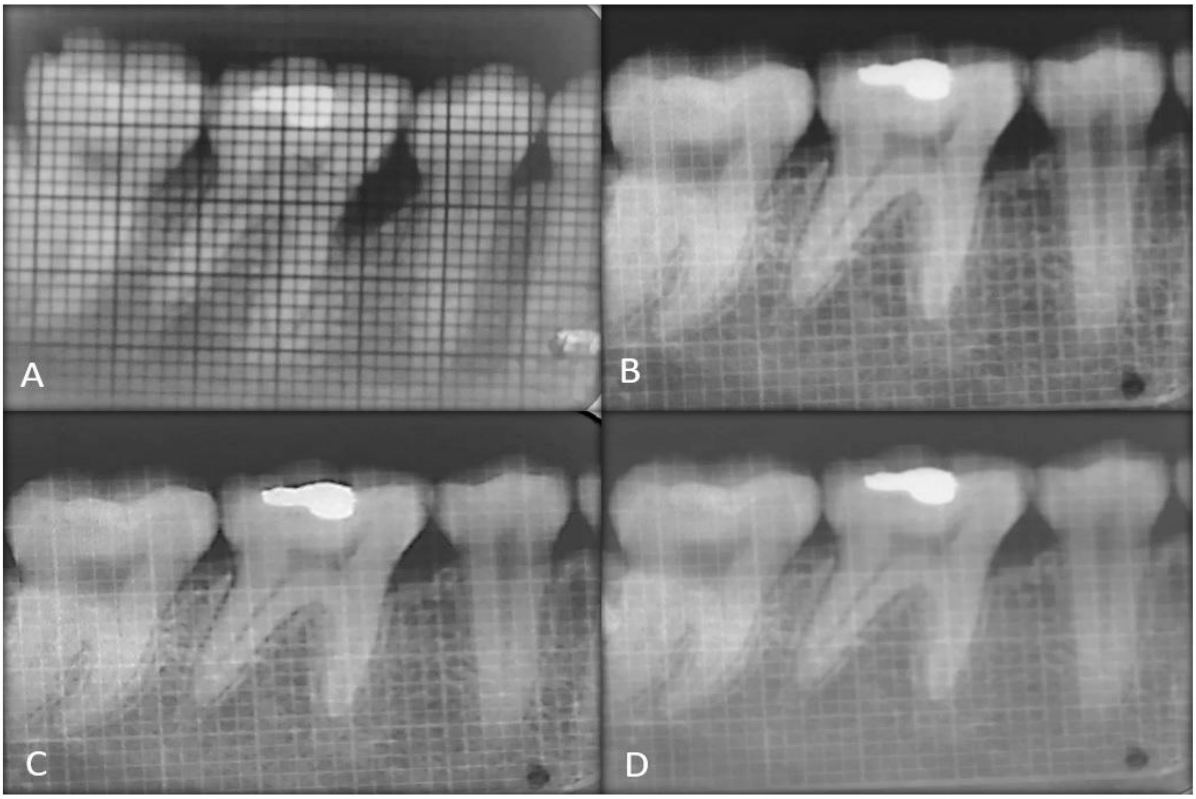

Fig: 4 - Group A, A - Preoperative IOPA ,B - 3 months postoperative IOPA, C - 6 months postoperative IOPA, D- 9 months postoperative IOPA

Footnote IOPA – Intraoral periapical radiograph

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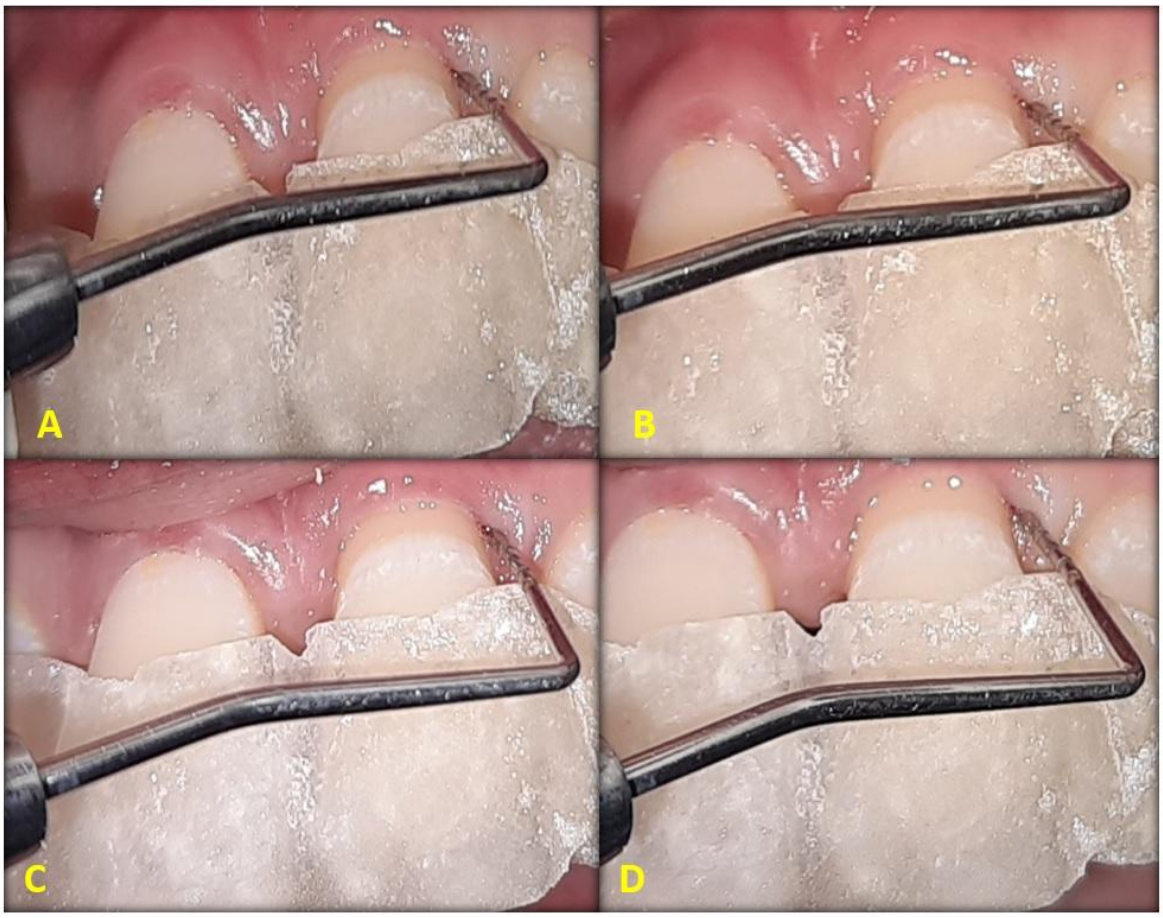

Fig :5 - Group B, A - Preoperative,B - 3 months postoperative, C - 6 months postoperative , D- 9 months postoperative

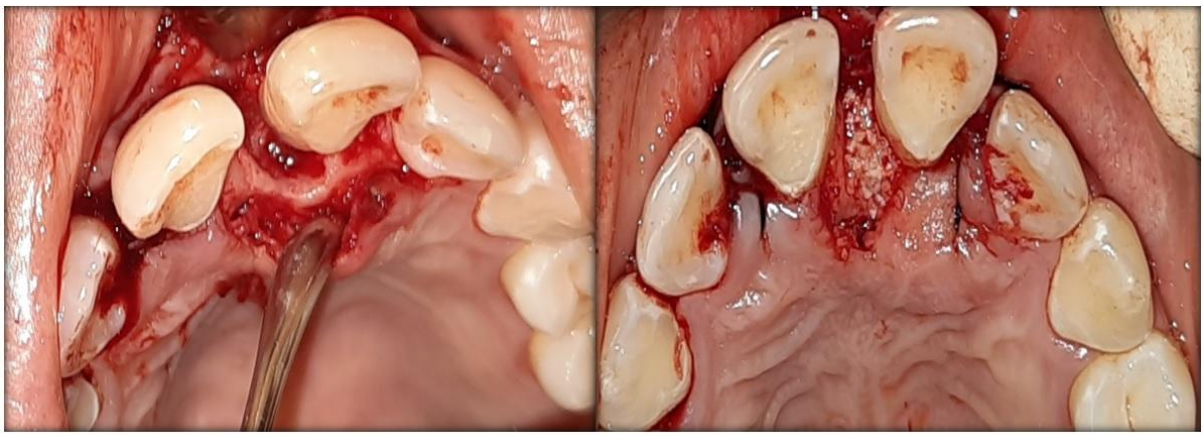

Fig :6 - Group B, A - Intrabony defect exposure, B-Placement of bio-oss

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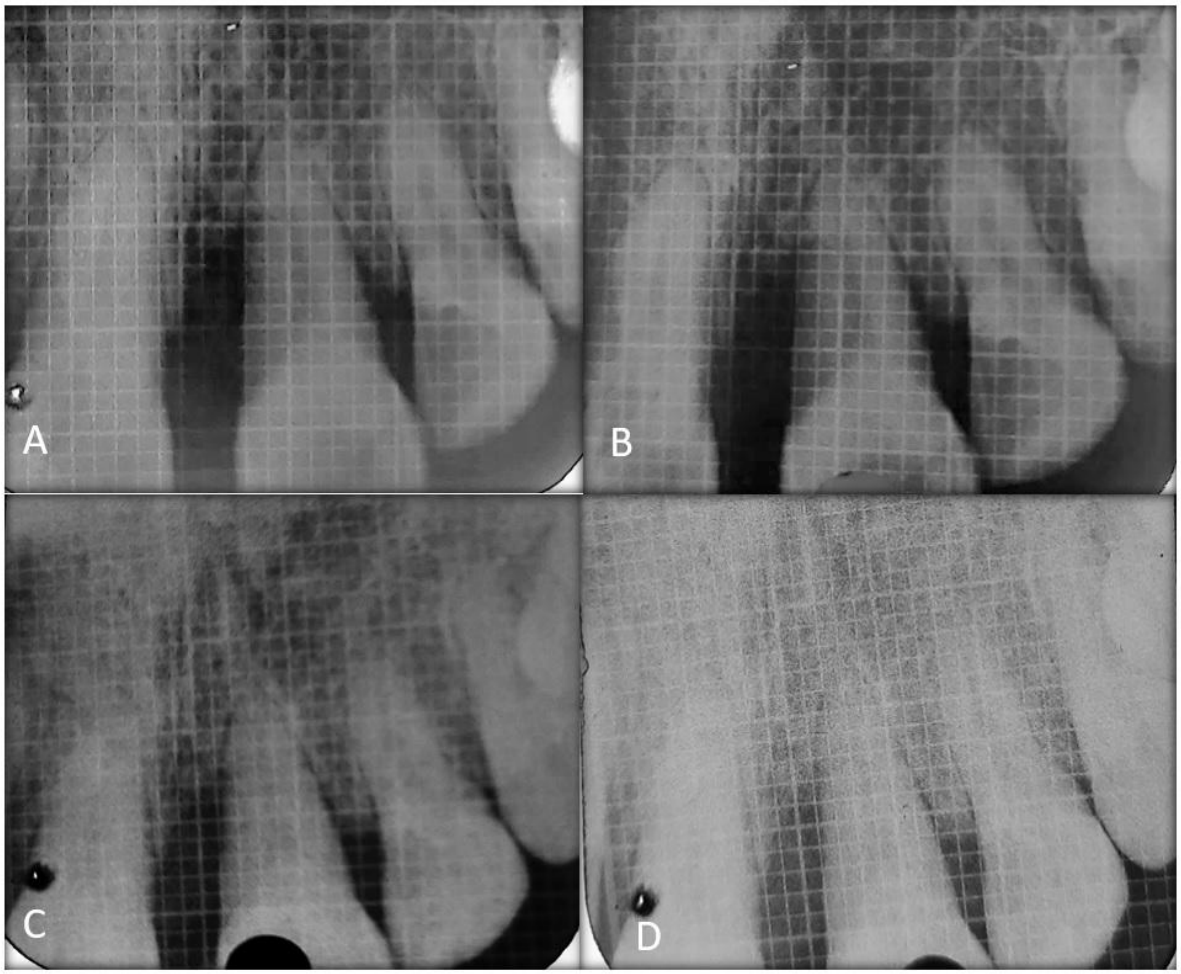

FIG : 7 - Group B, A - Preoperative IOPA ,B - 3 months postoperative IOPA, C - 6 months postoperative IOPA, D- 9 months postoperative IOPA

Footnote IOPA – Intraoral periapical radiograph

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GROUP A O.2% HYALURONIC ACID GEL WITH BOVINE POROUS BONE GRAFT																		
			BASELINE				3 MONTHS				6 MONTHS				9 MONTHS			
SL.NO	AGE [Years	SEX [M/F]	PI	GBI %	PPD	CAL	PI	GBI %	PPD	CAL	PI	GBI %	PPD	CAL	PI	GBI %	PPD	CAL
1	26	1	2.7	75.4	8	7	1.8	17.9	5	4	1.2	15.6	4	3	0.9	13.7	4	3
2	31	1	2.3	79.2	7	6	1.5	26.9	5	4	0.9	18.6	2	2	0.8	14.1	3	3
3	25	1	2.3	78.4	8	7	1.4	18.3	4	3	0.8	15	3	2	0.6	13.6	3	2
4	48	2	1.9	79.1	9	9	1	27.9	4	6	0.4	15	4	2	0.4	12.7	4	2
5	26	2	2.2	76.2	7	6	1.6	21.2	4	3	1.1	18.4	3	2	0.8	12.5	3	2
6	45	1	2.5	82.4	12	10	2	16.2	4	7	1	12.2	4	2	0.8	10.5	3	2
7	32	2	1.4	69.2	8	8	1.1	18.7	4	4	0.5	12.8	3	3	0.3	9.4	2	2
8	33	2	2.6	74.6	8	7	2.1	28.6	4	4	0.9	18.7	3	3	0.9	16.2	2	2
9	33	1	2.1	73.2	8	6	1.6	22.6	5	2	0.8	16.5	3	2	0.4	14.2	3	2
10	34	2	2.4	75.1	7	5	1.4	23.9	4	2	0.7	14.6	2	0	0.3	12.5	2	0

GROUP B BOVINE POROUS BONE GRAFT ALONE																		
			BASELINE				3 MONTHS				6 MONTHS				9 MONTHS			
SL. NO	AGE	SEX	PI	GBI %	PPD	CAL	PI	GBI %	PPD	CAL	PI	GBI %	PPD	CAL	PI	GBI %	PPD	CAL
1	47	2	2.4	81.2	10	9	1.9	39.4	5	4	1.1	21.5	4	3	0.9	19.4	4	2
2	38	1	2.1	79.2	9	8	1.2	30.7	5	4	1.1	18.3	4	3	0.4	16.4	3	2
3	44	1	2.3	82.6	8	6	1.6	28.2	6	4	0.9	15.7	5	3	0.6	12.8	4	3
4	37	2	2.6	77.4	6	5	1.8	21.9	5	4	1.1	14.1	4	3	0.8	12.8	3	2
5	47	1	2.1	80.5	7	7	1.6	31.4	5	5	1.1	23	4	4	0.5	12.9	3	3
6	26	1	1.9	76.8	8	7	1.1	26.3	5	4	1	19.3	3	2	0.4	15.7	3	3
7	39	2	1.8	69.4	7	6	1	22.1	5	4	1	14.2	4	3	0.3	13.8	4	3
8	32	2	2.8	81.3	9	9	2.1	34.1	5	5	1	27.6	4	4	0.6	19.6	4	3
9	40	1	2.5	78.4	8	6	1.6	21.3	4	2	0.7	16.3	3	2	0.6	15.7	3	2
10	27	1	2.7	76.1	9	7	1.5	45.7	6	4	1.1	27	4	2	0.5	14.6	4	2

TABLE 4- RADIOGRAPHIC PARAMETERS [AFTER APPLYING CORRECTION FACTOR]

GROUP A

	3 MONTHS						6 MONTHS						9 MONTHS					
SL.NO	BONE FILL	BONE FILL %	BONE CREST CHANGE	BONE CREST CHANGE %	DEFECT RESOLUTION	DEFECT RESOLUTION %	BONE FILL	BONE FILL %	BONE CREST CHANGE	BONE CREST CHANGE %	DEFECT RESOLUTION	DEFECT RESOLUTION %	BONE FILL	BONE FILL %	BONE CREST CHANGE	BONE CREST CHANGE %	DEFECT RESOLUTION	DEFECT RESOLUTION %
1	1.83	20	0.51	15	1.32	30	2.9	44	0.489	14	2.4	69	8.6	94	0.08	2.49	8.52	72
2	2.79	23	1.74	36	1.05	26	4.12	35	2.05	42	2.07	49	5.4	46	2.76	57	2.64	59
3	3.18	23	1.04	28	2.14	59	3.9	28	1.3	36	2.6	31	4.3	33	2.12	58	2.18	39
4	3.66	42	1.26	42	2.4	37	4.22	48	1.3	44	2.92	93	5.64	65	2.1	70	3.54	95
5	3.83	35	0.39	27	3.44	79	4.83	44	0.49	33	4.34	75	5.17	48	0.787	53	4.383	79
6	4.9	51	0.17	7	4.73	70	5.28	54	0.57	23	4.71	72	6	61	1.56	63	4.44	74
7	3.7	33	0.74	16	2.96	75	4.6	41	1.69	36	2.91	63	5.22	46	2.02	43	3.2	89
8	2.38	26	1.65	28	0.73	20	3.4	36	2.68	45	0.72	24	3.93	42	2.96	49	0.97	35
9	1.7	20	0.46	27	1.24	32	2.62	30	0.74	44	1.88	34	3.81	44	0.78	47	3.03	64
10	3.13	24	1.37	31	1.76	39	3.64	28	1.21	27	2.43	42	4.79	37	2.23	50	2.56	50

GROUP B

	3 MONTHS						6 MONTHS						9 MONTHS					
SL.NO	BONE FILL	BONE FILL %	BONE CREST CHANGE	BONE CREST CHANGE %	DEFECT RESOLUTION	DEFECT RESOLUTION %	BONE FILL	BONE FILL %	BONE CREST CHANGE	BONE CREST CHANGE %	DEFECT RESOLUTION	DEFECT RESOLUTION %	BONE FILL	25	BONE CREST CHANGE	BONE CREST CHANGE %	DEFECT RESOLUTION	DEFECT RESOLUTION %
1	3.83	31	0.167	20	1.723	60	3.22	34	0.45	10	2.77	69	3.9	41.3	0.996	22	2.904	86
2	3.83	31	0.05	25	1.53	38	3.37	32	1.04	27	2.33	67	4.49	43	1.29	32	3.2	95
3	3.83	31	0.851	26	0.809	22	2.78	32	1.14	30	1.64	31	4.78	56	2.05	55	2.73	45
4	3.83	31	1.87	20	1.96	30	6.05	49	2.1	43	3.95	69	6.41	52	2.32	47	4.09	76
5	1.93	20	0.25	25	1.68	39	3.33	35	0.6	17	2.73	78	3.93	41	0.97	27	2.96	82
6	2	20	1.22	23	1.36	20	3.37	26	1.42	27	1.95	38	4.49	35	2.2	42	2.29	51
7	1.106	20	0.26	20	0.846	22	2.29	30	0.74	25	1.55	36	2.77	36	1.12	37	1.65	42
8	2.5	20	0.51	10	0.77	20	2.8	35	1.45	29	1.35	73	3.3	41	1.66	34	1.64	100
9	2.82	28	0.13	25	2.69	38	3.45	33	0.32	18	3.13	60	4.13	40	0.66	36	3.47	60
10	1.58	18	0.55	25	1.03	23	2.96	33	1.05	29	1.91	49	3.82	43	1.6	47	2.22	77

TABLE 4- RADIOGRAPHIC PARAMETERS [AFTER APPLYING CORRECTION FACTOR]

GROUP A

	3 MONTHS						6 MONTHS						9 MONTHS					
SL.NO	BONE FILL	BONE FILL %	BONE CREST CHANGE	BONE CREST CHANGE %	DEFECT RESOLUTION	DEFECT RESOLUTION %	BONE FILL	BONE FILL %	BONE CREST CHANGE	BONE CREST CHANGE %	DEFECT RESOLUTION	DEFECT RESOLUTION %	BONE FILL	BONE FILL %	BONE CREST CHANGE	BONE CREST CHANGE %	DEFECT RESOLUTION	DEFECT RESOLUTION %
1	1.83	20	0.51	15	1.32	30	2.9	44	0.489	14	2.4	69	8.6	94	0.08	2.49	8.52	72
2	2.79	23	1.74	36	1.05	26	4.12	35	2.05	42	2.07	49	5.4	46	2.76	57	2.64	59
3	3.18	23	1.04	28	2.14	59	3.9	28	1.3	36	2.6	31	4.3	33	2.12	58	2.18	39
4	3.66	42	1.26	42	2.4	37	4.22	48	1.3	44	2.92	93	5.64	65	2.1	70	3.54	95
5	3.83	35	0.39	27	3.44	79	4.83	44	0.49	33	4.34	75	5.17	48	0.787	53	4.383	79
6	4.9	51	0.17	7	4.73	70	5.28	54	0.57	23	4.71	72	6	61	1.56	63	4.44	74
7	3.7	33	0.74	16	2.96	75	4.6	41	1.69	36	2.91	63	5.22	46	2.02	43	3.2	89
8	2.38	26	1.65	28	0.73	20	3.4	36	2.68	45	0.72	24	3.93	42	2.96	49	0.97	35
9	1.7	20	0.46	27	1.24	32	2.62	30	0.74	44	1.88	34	3.81	44	0.78	47	3.03	64
10	3.13	24	1.37	31	1.76	39	3.64	28	1.21	27	2.43	42	4.79	37	2.23	50	2.56	50

GROUP B

	3 MONTHS						6 MONTHS						9 MONTHS					
SL.NO	BONE FILL	BONE FILL %	BONE CREST CHANGE	BONE CREST CHANGE %	DEFECT RESOLUTION	DEFECT RESOLUTION %	BONE FILL	BONE FILL %	BONE CREST CHANGE	BONE CREST CHANGE %	DEFECT RESOLUTION	DEFECT RESOLUTION %	BONE FILL	25	BONE CREST CHANGE	BONE CREST CHANGE %	DEFECT RESOLUTION	DEFECT RESOLUTION %
1	3.83	31	0.167	20	1.723	60	3.22	34	0.45	10	2.77	69	3.9	41.3	0.996	22	2.904	86
2	3.83	31	0.05	25	1.53	38	3.37	32	1.04	27	2.33	67	4.49	43	1.29	32	3.2	95
3	3.83	31	0.851	26	0.809	22	2.78	32	1.14	30	1.64	31	4.78	56	2.05	55	2.73	45
4	3.83	31	1.87	20	1.96	30	6.05	49	2.1	43	3.95	69	6.41	52	2.32	47	4.09	76
5	1.93	20	0.25	25	1.68	39	3.33	35	0.6	17	2.73	78	3.93	41	0.97	27	2.96	82
6	2	20	1.22	23	1.36	20	3.37	26	1.42	27	1.95	38	4.49	35	2.2	42	2.29	51
7	1.106	20	0.26	20	0.846	22	2.29	30	0.74	25	1.55	36	2.77	36	1.12	37	1.65	42
8	2.5	20	0.51	10	0.77	20	2.8	35	1.45	29	1.35	73	3.3	41	1.66	34	1.64	100
9	2.82	28	0.13	25	2.69	38	3.45	33	0.32	18	3.13	60	4.13	40	0.66	36	3.47	60
10	1.58	18	0.55	25	1.03	23	2.96	33	1.05	29	1.91	49	3.82	43	1.6	47	2.22	77

INTRAGROUP COMPARISON GROUP B CLINICAL AND RADIOGRAPHIC PARAMETERS					
PARAMETERS	BASELINE	3RD MONTH	6TH MONTH	9TH MONTH	P VALUE
PI	2.32±0.34	1.54±0.35	0.99± 07	0.58±0.16	0.001
GBI	78.29±3.78	30.11±7.99	19.7±4.96	15.37±2.53	0.001
PPD	8.1±1.20	5.1±0.57	3.9±0.57	3.5±0.53	0.001
CAL	7±1.33	4±0.82	2.9±0.74	2.6±0.52	0.001

GROUP B			
PARAMETERS		**MEAN ±SD**	**P VALUE**
Bone fill	3 months	2.73±1.06	0.002
	6 months	3.04±0.37	
	9 months	4.20±0.98	
Bone fill %	3 months	26.00±5.29	0.007
	6 months	32.20±2.66	
	9 months	42.83±6.52	
Bone crest change	3 months	0.59±0.58	0.001
	6 months	1.03±0.54	
	9 months	1.49±0.57	
Bone crest change %	3 months	21.90±4.82	0.001
	6 months	25.50±8.97	
	9 months	37.90±10.01	
Defect resolution	3 months	1.44±0.61	0.001
	6 months	2.53±1.11	
	9 months	2.72±0.78	
Defect resolution in %	3 months	31.20±12.79	0.005
	6 months	45.20±10.24	
	9 months	56.30±20.55	

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