Effect of Scaffold of Bioactive Glass in the Treatment of Periodontal Bony Defects. A Prospective Clinical Study

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ABSTRACT

Introduction: Bioactive glass seems to promote osteogenesis, and helps in rapid bone formation. The purpose of the present study was to evaluate clinical and radiographical effect of scaffold of bioactive glass in the treatment of different forms of periodontal bony defects.

Methods: Total 44 different types of periodontal bony defects site were selected from total 15 patients for the study. A split mouth technique was used to compare the test sites and control sites. In each patient, the test site was treated with both bioglass scaffold and GTR membrane. Control site was treated with GTR membrane alone. The patients were grouped as: Group A: intrabony periodontal defects (n= 24 defects); Group B: suprabony periodontal defects (n= 10 defects); Group C: furcation involvement (n=10 teeth with grade II furcation). Parmeter's evaluated were gingival index (GI), plaque index (PI), probing pocket depth (PPD), relative attachment level (RAL) and radiological bone height (RBH) at baseline and 6-month post operative. Intergroup comparison was done using independent t test and intragroup comparison was done using dependent t test.

Results: There was no statistically significant improvement in the GI and PI scores from baseline to 6 months following surgery in three groups. When three groups compared together, there was a significant reduction of 3.07 mm PPD at test sites and 1.79 mm at control sites. When three groups compared together, test sites showed a reduction of 3.16 mm of RAL at test sites and 2.61 mm at control sites. Six months postoperative follow up results showed a statistically significant bone fill in case of intrabony defects and furcation defects but statistically insignificant bone fill was noticed in case of suprabony defects. When RBH of two groups (Group A and Group B) compared together, the test site showed a mean radiological defect fill of 3.04 mm at test site and 2.42 mm at control site, but difference was insignificant.

Conclusion: Within the limitations of this study, six months postoperative follow up results showed significant bone fill in case of intrabony defects and furcation defects, but it was insignificant in case of suprabony defects. There was no significant improvement in GI and PI scores during follow-up. PPD and RAL showed better improvement in test sites compared to control sites. The scaffold of bioactive glass showed better results in periodontal bony defects in test sites compared to control sites.

Keywords: Bioactive glass; Bone defects; Furcation; Periodontium; Scaffolds

Conflict of Interest: None

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INTRODUCTION

Periodontal bony defects are sub classified as intrabony defects (angular/vertical defect) and suprabony defects (horizontal). In case of intrabony defect, the base of the pocket is apical to the residual bone crest, whereas in case of suprabony defects, the base of

the pocket is at the level of the residual bone crest.[1]The furcation is termed as the anatomic area of a multirooted tooth, where the roots diverge. Furcation invasion is mainly due to the pathologic resorption of the supporting alveolar bone within a furcation due to chronic or aggressive periodontitis.[2]

One of the important purposes of the periodontal treatment is the regeneration of the lost part of periodontium. Traditional periodontal therapy which includes scaling and root planning are very beneficial in repair of periodontal defects and seizing its progression. However, they had limited role in promoting regeneration of the periodontium which was already lost.[3,4] On the other hand, periodontal therapy, mainly regenerative periodontal surgeries not only help in the elimination of pocket depths, but also it aids in regeneration of the lost part of the periodontium. Thus, it helps in reconstruction of the periodontium to its normal physiologic limits.[5,6]

Since many years these periodontal defects were treated with the use of different bone graft materials. Placing guided tissue regeneration (GTR) membrane in theses bone defects as mechanical barrier has demonstrated its effectiveness in periodontal regeneration.[7] The ultimate goal of bone graft is to induce osteogenesis, cementogenesis, and helps in achieving a more coronal attachment of periodontal ligament to the root surface, compare to its original level.[8]

Osteogenesis is the generation of mineralized bone with the help of osteoblasts, and it is mainly obtained using autogenous grafts.[9] Bone substitutes used in periodontal defects do not provide any cellular elements. The bone substitutes are usually osteoconductive in nature and inert materials get integrated with the new bone. These osteoconductive materials lay out a scaffold, which allows in growth and bone deposition. Bone substitutes help in significant reduction in clinical probing depth and attachment levels.[10,11]

Various alloplastic materials such as ceramics, collagen and polymers were being used to fill the bony defects.[12] These synthetic materials can be either bioactive or bioinert in nature. Bioactive ceramics includes fluorapatite, hydroxyapatite (HA), tricalcium phosphate and bioglass.[13] Bioactive glass consists of CaO, Si02, Na20, P2O5. They bond to the bone with the formation of a surface layer of carbonated HA. Bioactive glass seems to promote osteogenesis, and helps in rapid bone formation. Earlier bioglass was used in powder form which gets dissolved easily in blood and washed out.[14,15]

Scaffold is interim structure which provides support to the material in the construction and thus helps in the repair of large structures.[16] Regeneration needs an intact connective tissue scaffold. Scaffolds are necessary as they lay out framework for cell migration and keep the correct cell polarity for the re-assembly of the bone tissue.[17] In the present study bioglass has been used in porous scaffold form with 40% surface porosity. It was used in the physical form (porous scaffold) with an attempt that it might act as a spacer and the porous network of the scaffold might allow the osteogenic cells to infiltrate into the scaffold of bioglass placed in the bony defects.[18]

The purpose of the present study was to evaluate clinical and radiographical effect of scaffold of bioactive glass in the treatment of different forms of periodontal bony defects. The null hypothesis was that there would be no difference in the treatment of periodontal bone defect with the use of scaffold of bioactive glass.

METHODS

This prospective clinical study was done in the Department of Periodontics, Dr. R. Ahmed Dental College and Hospital, Kolkata, India along with technical support from

Bioceramic and Coating Division, Central Glass and Ceramic Research Institute, Jadavpur University, Kolkata, India. The ethical clearance was obtained from the Ethical Committee of Dr. R. Ahmed Dental College and Hospital, Kolkata, India.

Inclusion and exclusion criteria

Both male and female patient aged 35-65 years, who were motivated to undergo treatment and willing to complete follow up were included in the study. Patients having different types of alveolar bone defects due to periodontitis and having good general health and oral hygiene habits were only included. Patients with mobile tooth, having tobacco habits, history of radiation therapy within last 6 months, presence of systemic disease were excluded. Patients with parafunctional habits, immunocompromised patient, pregnant or lactating woman and patients allergic to bioglass materials were excluded.

Recruitment and grouping

The subjects were recruited from the outpatient department of Oral Diagnosis Oral Medicine and Radiology, Dr. R. Ahmed Dental College and Hospital, Kolkata, India. The objective of the study was explained to each patient. The medical and dental history was taken. Clinical examination was done in the Department of Periodontics and the defects were assessed both clinically and radiographically. After selection of the patients a written consent was obtained from each patient.

Total 44 different types of periodontal bony defect sites were present in 15 patients for the study. A split mouth technique was used to compare the test sites and control sites. In some patients there was more than two defect sites. In this study a simple randomization by flipping a coin for every patient was done and it resulted in 27 test sites and 17 control sites. In each patient, the test site was treated with both bioglass scaffold and GTR membrane. GTR membrane (PerioCol-GTR, Eucare Pharmaceuticals Private Limited, Chennai, India) was placed at both test and control site to maintain uniformity and to prevent the epithelial migration. Control site was treated with GTR membrane alone without placing any grafts in the defect.

The patients were grouped as:
Group A: Patients having intrabony periodontal defects (n= 24 defects); Group B: Patients having suprabony periodontal defects (n= 10 defects); Group C: Patients having furcation involvement (n=10 teeth with grade II furcation).

Parmeter's evaluated

Following parameter were evaluated in the study up to nearest millimeter with the help of a University of North Carolina (UNC-15) probe and (Naber's Probe in case of furcation defects) for each surgical site on the day of surgery (baseline) and after 6 months post operatively.[19]

The Gingival Index (GI) proposed by Löe and Silness was used to assess gingival health, where a score of 0 indicated normal gingiva and a score of 3 indicated severe gingival inflammation. The Plaque Index (PI) developed by Silness and Löe was used to evaluate plaque accumulation, with a score of 0 indicating no plaque in the gingival area and a score of 3 indicating abundant soft deposits within the gingival pocket and/or on the gingival margin and adjacent tooth surface. Four surfaces were scored for both the gingival and plaque indices. Probing pocket depth (PPD) was also measured as the distance from the gingival margin to the base of the periodontal pocket. Relative attachment level (RAL) was measured as the vertical distance from a fixed reference point (as marked on the stent) to the base of the periodontal pocket. Radiological bone height (RBH) was measured with the help of intra oral periapical radiograph at baseline and 6-month post operative.[19-24]

Occlusal stents using cold cure polymerizing resin were fabricated in the area of interest. First

a sterile perforated stock metal impression tray for each patient was selected. Then impressions were made using alginate, following which casts were poured utilizing dental stone. Occlusal stents were fabricated on the obtained cast.[24]

Bioglass Scaffold Preparation

Using traditional glass melting procedure, a series of glasses in the SiO_2-Na_2O-ZnO-CaO-MgO-P_2O_5 system were prepared from reagent grade quartz (SiO_2), calcium carbonate ($CaCO_3$), Light Magnesium Carbonate ($MgCO_3$), dry soda ash (Na_2CO_3), di-ammonium hydrogen phosphate [$(NH_4)_2.HPO_4$] and other minor ingredients.[25] (Figure 1) From the bioactive glass obtained, porous (35–40% by volume) bioactive glass blocks were fabricated by using b-naphthalene and polyvinyl alcohol (G.R. grade, SDFine-Chem, India) as combustible organic materials. (Figure 2) For the purpose, bioactive glass powders were milled with oleic acid surfactant and pre-calculated amount of β-naphthalene. Blocks of bioglass were uniaxially cold compacted with low pressure, which were subsequently cold iso-statically pressed at 100 MPa for homogeneous densification. All specimens were slowly dried at 80°C for 3 days. Finally, bioactive glass specimens were sintered at 600 °C /1 h. The porous struts were initially pasteurized using distilled water and subsequently autoclaved at 121°C for 30 min. Then the blocks were sintered at 480°C for 30 minutes and gradually cooled in water bath to normal temperature. The Bioglass Scaffolds were subjected to Gamma radiation to obtain proper sterilization.[26]

Treatment protocol

All the patients underwent Phase I therapy comprising of scaling and root planning to eliminate the inflammatory component. Systemic history and routine haematological investigation were carried out prior to surgery to exclude any systemic disease. The patients were re-evaluated after every week for 4 weeks following which the surgical procedure was carried out. The probing depth levels and relative attachment levels were recorded.

Surgical procedure

Preparation with Povidone Iodine was carried out and local anesthesia was instituted. Then, crevicular incisions were given and the flaps were elevated by means of blunt dissection with the help of a periosteal elevator. The lining pocket epithelium was removed so that a fresh connective tissue bed was in contact with the graft material and utmost care was taken to preserve the interdental papilla. A thorough debridement was carried out in all the defect areas. All the granulation tissues were removed to ensure a clean site followed by thorough root planning.

The acrylic stent was then put in place and the measurement of the defect was recorded using a UNC-15 probe from the most apical part of the defect to the fixed reference mark on the stent. (Figure 3a,3b,3c,3d) An adequate quantity of the porous bioactive glass scaffold was properly shaped with the help of micromotor with surgical bur and file. Graft material was properly placed in the test site. GTR membrane was placed in both test and control site and fixed with the help of resorbable suture material. Coverage of the field of surgery with the flap was done. 4-0 non-resorbable silk sutures were used to approximate the lingual and buccal flaps using interrupted sutures. Periodontal pack was given to the surgical site. Patients were given routine post-surgical instructions and medicines were prescribed.

Follow-up

Patients were recalled one week after surgery; the periodontal pack and sutures were removed. Patients were given proper oral hygiene instruction to be followed. Patients were then periodically monitored at one month, then at three and six months after surgery. At each of the recall visits oral hygiene was assessed and oral

hygiene instructions were reinforced. 6 month post operative radiographs were subjected to computer assisted dental scan analysis for better and more accurate assessment of the defects. (Figure 4a, 4b)

Statistical analysis

All data obtained from the study was statistically analyzed using Statistical Package for Social Sciences Program (Version 17 for Windows, SPSS Inc., Chicago). Intergroup comparison was done using independent t test and intragroup comparison was done using dependent t test. $P<0.5$ was considered as significant.

RESULTS

Gingival Index

In Group A, Group B and Group C subjects, there was no statistically significant improvement in the gingival index scores from baseline to 6 months following surgery. There was no statistically significant difference in the gingival index scores at test and control sites (Table1, 2). When three groups compared together, there was no statistically significant improvement in the gingival index scores from baseline to 6 months following surgery (Table 3 and 4).

Plaque Index

In Group A, Group B and Group C subjects, there was no statistically significant improvement in the plaque index scores from baseline to 6 months following surgery. There was no statistically significant difference in the plaque index scores at test and control sites too (Table1, 2). When three groups were compared together, there was no statistically significant improvement in the plaque index scores from baseline to 6 months following surgery (Table 3, 4).

Probing depth

In Group A subjects, the test site showed a mean probing pocket depth (PPD) of 7.21 mm at baseline and 3.87 mm at the end of six months. Thus, a mean reduction of 3.34 mm was achieved which was statistically significant ($P<0.01$). The mean PPD in the control site was 6.95 mm at baseline and 4.81 mm at the end of 6 months, showing a mean reduction of 2.14 mm, which was also statistically significant ($P<0.01$). When comparison was done between the test and control sites, it was found to be statistically significant (Table1, 2).

In Group B subjects, the test site showed a mean PPD of 7.08 mm at baseline and 5.16 mm at the end of six months. Thus, a mean reduction of 1.92 mm was achieved which was statistically significant. The mean PPD in the control site was 7.25 mm at baseline and 6.25 mm at the end of 6 months, showing a mean reduction of 1.00 mm, which was also statistically significant. When comparison was done between the test and control sites, it was found to be statistically insignificant (Table1, 2).

In Group C subjects, the test site showed a mean PPD of 4.71 mm at baseline and 1.28 mm at the end of six months. Thus, a mean reduction of 3.43 mm was achieved which was statistically significant. The mean PPD in the control site was 5.14 mm at baseline and 2.85 mm at the end of 6 months, showing a mean reduction of 2.29 mm, which was also statistically significant. When comparison was done between the test and control sites, it was found to be statistically significant (Table1, 2).

When three groups compared together, the test site showed a mean PPD of 6.58 mm at baseline and 3.51 mm at the end of six months. Thus, a mean reduction of 3.07 mm was achieved which was statistically significant. The mean PPD in the control site was 6.18 mm at baseline and 4.39 mm at the end of 6 months, showing a mean reduction of 1.79 mm, which was also statistically significant (Table 3, 4).

Relative attachment level

In Group A subjects, the test site showed a mean relative attachment level (RAL) of 10.65mm at

baseline and 7.34 mm at the end of six months. Thus, a mean reduction of 3.31 mm was achieved which was statistically significant. The control site showed a mean RAL of 10.50 mm at baseline and 7.43 mm at the end of six months. Thus, a mean reduction of 3.07 mm was achieved which was statistically significant. When comparison was done between the test and control sites, it was found to be statistically insignificant (Table1, 2).

In Group B subjects, the test site showed a mean RAL of 10.50 mm at baseline and 7.25 mm at the end of six months. Thus, a mean reduction of 3.25 mm was achieved which was statistically significant. The control site showed a mean RAL of 9.25 mm at baseline and 7.25 mm at the end of six months. Thus, a mean reduction of 2.00 mm was achieved which was statistically significant. When comparison was done between the test and control sites, it was found to be statistically insignificant (Table1, 2).

In Group C subjects, the test site showed a mean RAL of 9.28 mm at baseline and 6.57 mm at the end of six months. Thus, a mean reduction of 2.71mm was achieved which was statistically significant. The control site showed a mean RAL of 9.07 mm at baseline and 6.64 mm at the end of six months. Thus, a mean reduction of 2.43 mm was achieved which was statistically significant. When comparison was done between the test and control sites, it was found to be statistically insignificant (Table1, 2).

When three groups compared together, the test site showed a mean RAL of 10.29 mm at baseline and 7.13 mm at the end of six months. Thus, a mean reduction of 3.16 mm was achieved which was statistically insignificant. The control site showed a mean RAL of 9.71 mm at baseline and 7.10 mm at the end of six months. Thus, a mean reduction of 2.61 mm was achieved which was statistically insignificant (Table 3, 4).

Radiological bone height

In Group A subjects, the test site showed a mean radiological bone height (RBH) of 16.00 mm at baseline and 12.65 mm at the end of six months. Thus, a mean radiological defect fill of 3.35 mm was achieved which was statistically significant when compared to baseline. The mean RBH in the control site was 17.56 mm at baseline and 14.43 mm at the end of 6 months, showing a mean defect fill of 3.13 mm, and was also statistically significant. When comparison was done between the test and control sites, it was found to be statistically insignificant (Table1 and 2).

In Group B subjects, the test site showed a mean RBH of 16.83 mm at baseline and 14.58 mm at the end of six months. Thus, a mean radiological defect fill of 2.25 mm was achieved which was statistically significant when compared to baseline. The mean RBH in the control site was 16.25 mm at baseline and 15.25 mm at the end of 6 months, showing a mean defect fill of 1.00 mm, and was also statistically significant. When comparison was done between the test and control sites, it was found to be statistically insignificant (Table1 and 2).

When two groups compared together, the test site showed a mean RBH of 16.22 mm at baseline and 13.18 mm at the end of six months. Thus, a mean radiological defect fill of 3.04 mm was achieved which was statistically significant when compared to baseline. The mean RBH in the control site was 17.12 mm at baseline and 14.70 mm at the end of 6 months, showing a mean defect fill of 2.42 mm, and was also statistically insignificant (Table 3 and 4).

Table 1: Mean and standard deviation of different periodontal conditions between case and control groups during baseline

Group		No	GI		PI		PPD		RBH		RAL	
			M	SD	M	SD	M	SD	M	SD	M	SD
Group A	Test	16	0.00	0.00	0.00	0.00	7.21	0.70	16.00	2.90	10.65	1.30
	Control	8	0.00	0.00	0.00	0.00	6.65	0.94	17.56	5.60	10.50	1.69
	t-Value		--		--		1.92		-0.90		0.25	
Group B	Test	6	0.00	0.00	0.00	0.00	7.08	1.02	16.83	3.25	10.50	1.64
	Control	4	0.00	0.00	0.00	0.00	7.25	1.32	16.25	3.30	9.25	1.50
	t-Value		--		--		-0.22		0.27		1.21	
Group C	Test	5	0.00	0.00	0.00	0.00	4.71	1.11	--	--	9.28	1.42
	Control	5	0.00	0.00	0.00	0.00	5.14	1.06	--	--	9.07	0.73
	t-Value		--		--		-0.73		--		0.42	

GI-gingival index; PI-plaque index; PPD-probing pocket depth; RBH-radiological bone height; RAL-relative attachment level; M-Mean; SD-Standard deviation

Table 2: Mean and standard deviation of different periodontal conditions between case and control groups after 6 months of treatment

Group		No	GI		PI		PPD		RBH		RAL	
			M	SD	M	SD	M	SD	M	SD	M	SD
Group A	Test	16	0.90	0.12	0.96	0.12	3.87	0.38	12.65	2.76	7.34	1.12
	Control	8	0.90	0.12	0.93	0.11	4.81	0.99	14.43	3.65	7.43	1.54
	t-Value		0.00		0.59		3.34 **		-1.33		0.17	
Group B	Test	6	0.95	0.10	0.95	0.10	5.16	0.75	14.58	2.72	7.25	1.60
	Control	4	1.00	0.00	0.93	0.12	6.25	1.32	15.25	3.30	7.25	1.19
	t-Value		0.80		0.29		-1.67		-0.34		0.00	
Group C	Test	5	0.96	0.09	0.96	0.09	1.28	0.75	--	--	6.57	0.78
	Control	5	0.92	0.12	0.92	0.12	2.85	1.06	--	--	6.64	0.74
	t-Value		0.61		0.61		3.17 **		--		0.17	

**p<0.01 is significant

Table 3: Mean and standard deviation of different periodontal conditions between case and control group (including all groups) during baseline

Group D	No	GI		PI		PPD		RBH		RAL	
		M	SD	M	SD	M	SD	M	SD	M	SD
Test	27	0	0.00	0	0.00	6.58	1.36	16.22	2.95	10.29	1.41
Control	17	0	0.00	0	0.00	6.18	1.32	17.12	4.83	9.71	1.46
t-Value		--		--		1.00		0.67		1.37	

Table 4: Mean and standard deviation of different periodontal conditions between case and control group (including all groups) after 6 months of treatment

Group D	No	GI		PI		PPD		RBH		RAL	
		M	SD	M	SD	M	SD	M	SD	M	SD
Test	27	0.93	0.11	0.96	0.11	3.51	1.48	13.18	2.82	7.13	1.17
Control	17	0.93	0.11	0.93	0.11	4.39	1.67	14.70	3.41	7.10	1.21
t-Value		0.09		0.95		1.90 **		1.39		0.09	
Test	Reduction	0.93		0.96		3.07		3.04		3.16	
Control		0.93		0.93		1.79		2.42		2.61	

**p<0.01 is significant

Figure 1: *Bioglass*

Figure 2: *Porous bioactive glass Scaffold*

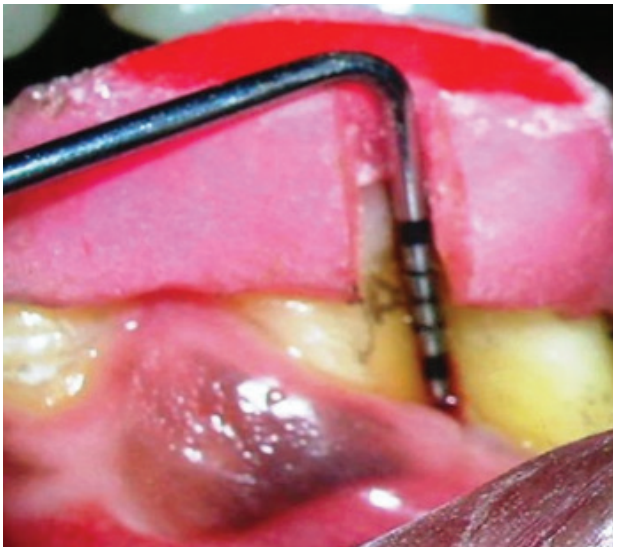

Figure 3a: *Baseline periodontal pocket depth and relative attachment level for control site (Group A)*

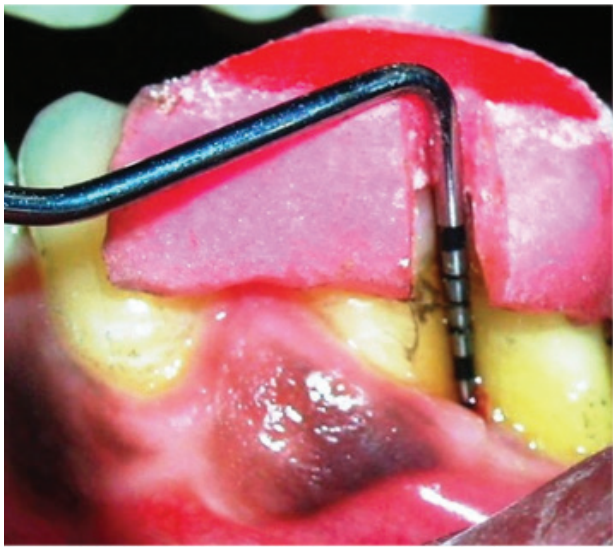

Figure 3b: *Periodontal pocket depth and relative attachment level for control site at 6 months (Group A)*

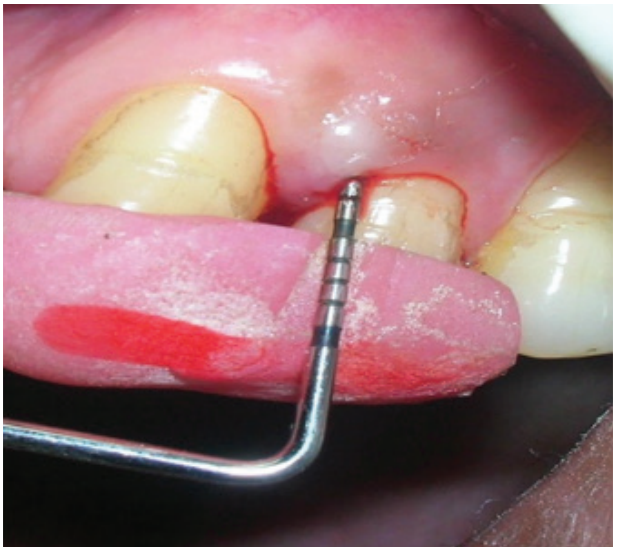

Figure 3c: *Baseline periodontal pocket depth and relative attachment level for test site (Group A)*

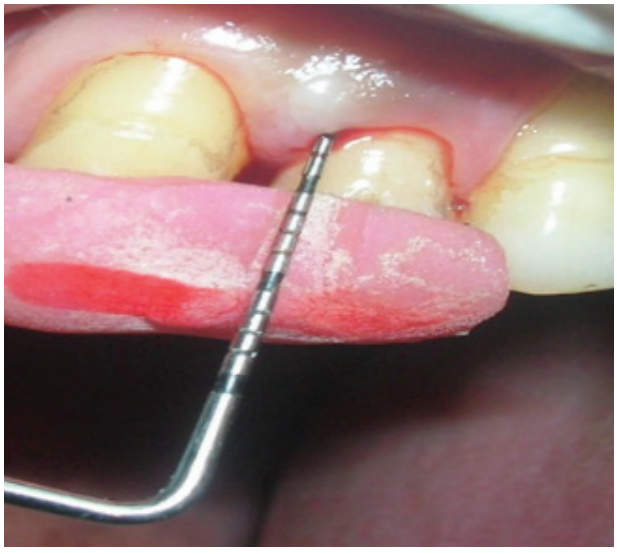

Figure 3d: *Periodontal pocket depth and relative attachment level for test site at 6 months (Group A)*

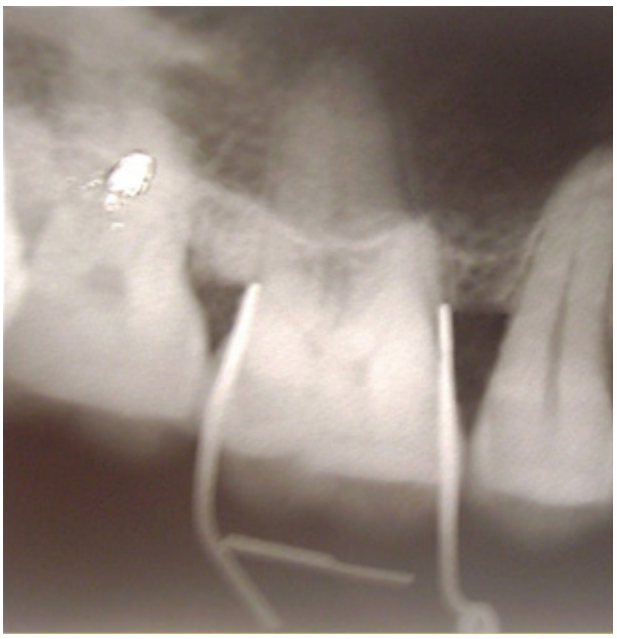

Figure 4A: *Baseline radiological bone level of Group B test site*

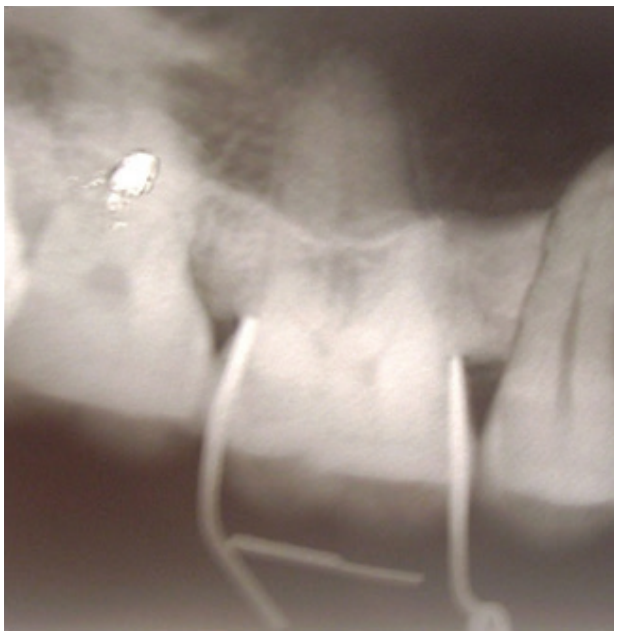

Figure 4b: *Radiological bone level of Group B test site at 6months*

DISCUSSION

Regeneration is a process of reconstruction or reproduction of completely lost or injured tissues so that their architecture and function can be completely restored. Periodontal disease leads to the progression of alveolar bone loss and destruction of periodontal ligament, along with necrosis of cementum and apical migration of epithelial attachment. It is clinically presented as formation of pocket, and creates a challenge to the clinician to regenerate the lost periodontium.[27] Periodontal regenerative therapy is considered as an important treatment aspect to replace or reconstitute the lost periodontal tissues which includes new alveolar bone, cementum, and periodontal ligament.[28,29]

Generally, it is rarely possible to achieve 100% regeneration. Different researchers had used bioactive glasses for different regenerative treatment modalities. Bioactive glasses are amorphous, silicate-based materials which forms a bond with bone and thus stimulate new bone growth.[25,30] With time bioglass gets dissolve and this makes them a candidate material for tissue engineering. Bioactive glass 45S5 implanted in rats was the first material which showed an interfacial bond with the host tissue.[31] The bonding of bioactive glass to bone has been attributed to the formation of a hydroxyl carbonate apatite (HCA) layer on the glass surface in contact with body fluid. HCA is similar to bone mineral and therefore forms a bond.[32] The strength of the interfacial bond formed in between the bioglass and cortical bone was similar or g more than the strength of the host bone.[33,34]

As the bone-tissue engineering progress, need of a scaffold arises, which seems necessary to in restoring the function.[25] This provides an alternative to in situ bone regeneration. According to local loading of the environment, the body must regenerate and remodel new bone tissue. As the body generates new bone, the scaffold which is placed gets dissolve at the same rate. the body creates new bone at the site. Porous bioglass scaffolds were also been used with success to treat different bony defects.[35,36] The pores in bioglass may makes the scaffolds brittle.[37]

In the present study indigenous scaffold of bioglass was prepared in the laboratory and was grafted in the osseous defects (intrabony

defects, suprabony defects and furcation defects) of the subjects of the test group. A split mouth technique was used to compare the test sites and control sites. The recording of possible regeneration was performed after six months postoperatively. The parameters assessed included PPD, RAL, GI, and plaque PI. The null hypothesis that there would be no difference in the treatment of periodontal bone defect with the use of scaffold of bioactive glass was rejected.

The result of present study represented that the mean reduction of the PPD at 6 month postoperatively was statistically significant ($p<0.01$) in both the test and control group but comparatively more satisfactory result was obtained in the test group. Froum et al[38] found significant improvements in probing pocket depths 6 to 7 months following open flap debridement. Similar reductions in pocket depth were described by Froum et al[39] with bioactive glass in 32 test sites. The result was similar to the result of a 6 month study by Park et al[40] who compared open flap debridement with bioactive glass to open flap debridement and observed a gain of 4.1+1.8 mm in test sites and 3.4+1.2 mm in control sites in mean gain of probing pocket depth.[40] Similar result was also showed by Sculean et al[41] in a systematic review comparing open flap debridement with graft material and barrier membrane to open flap debridement and barrier membrane. They observed better result in control sites in mean gain of probing pocket depth.

The results RAL and RBH in the present study showed that there were statistically insignificant differences observed between test and control groups 6 months postoperatively. The mean gain in relative attachment level was similar to those reported by Froum et al.[39] The results from this study were also similar in comparison to those observed by Lovelace et al[42] with 2.3+0.9 mm in bioactive glass group and Park et al[40] with 3.0+1.4 mm in bioactive glass group and 1.8+1.2 mm in open flap debridement group for gaining RAL.

In case of gain in RBH the result was in agreement with studies by Zamet et al,[43] and Froum et al,[39] in their clinical comparison of bony defects treated with bioactive glass and open flap debridement. Radiographs at best represent a two-dimensional picture of a three-dimensional defect, so in the present study 6 month post operative radiographs were subjected to computer assisted dental scan analysis for better and more accurate assessment of bone regeneration and it was found a greater radiographic bone height in test group.

Sculean et al[41] found in treating supra-alveolar defect the additional use of a grafting material gave superior result than barrier membranes alone which was not found in the present study. The variation may be due to smaller sample size and difference in materials used in the present study. But the present study showed similar result with Kaya et al[44] who found slight bone formation when compared with open flap debridement in horizontal bone defects according to pocket depth measurements.

PI and GI were kept at index score '0' by strict maintenance of oral hygiene and repeated scaling in all the subjects prior to surgery and after 6 months. The six-month post-operative result suggested that patient maintenance was good throughout the study. The gingival index too did not significantly differ in all the groups. Its significance is that since there was no change in gingival index and since plaque scores too were not altered, it can be suggested that the materials used were biocompatible and did not elicit any soft tissue inflammatory response.

Garrett et al 1996 has reviewed the regenerative procedure and remarked that in controlled clinical trials treating furcation defects and periodontal osseous defects nonabsorbable

and absorbable synthetic graft materials have consistently demonstrated clinical advantages beyond that achieved by debridement alone which was also found in the present study.[45] From the results of this study, it can be concluded that bioglass scaffold provided a significantly better result in comparison to non-grafted defect sites in case of treatment of infrabony and furcation involved periodontal defects but there was no significant difference found in the treatment of suprabony periodontal defects.

The limitations of this study were that true regeneration of periodontium in regenerative periodontal surgery can only be assessed by histological examination and this is not possible in human study due to ethical reason. Hence, clinical and radiological assessment was utilized only for post operative comparison of regeneration. Since this study consisted of only 44 sites comprising of all types of defects and because of the short study period a long-term study with a large sample size is required to come to a definite conclusion.

CONCLUSION

Within the limitations of this study following conclusion can be drawn:

1. There was insignificant improvement in the GI and PI scores from baseline to 6 months following surgery in three groups.
2. There was a significant reduction of PPD both at test and control sites.
3. Both test and control sites showed reduction in RAL during follow-up.
4. Both test and control sites showed improved RBH, although it was more at test sites.
5. Six months postoperative follow up results showed significant bone fill in case of intrabony defects and furcation defects but it was insignificant in case of suprabony defects.
6. The scaffold of bioactive glass showed better results in periodontal bony defects in test sites compared to control sites and thus it can be used in clinical cases of periodontal bone defects for improved results.

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