

Clinical Evaluation of Intrabony Defects in Localized Aggressive Periodontitis Patients with and without Bioglass- An In-vivo Study

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ABSTRACT

Background

Aggressive periodontitis is a specific type of periodontitis with clearly identifiable clinical characteristics such as “rapid attachment loss, bone destruction” and “familial aggregation”. Regeneration of mineralized tissues affected by aggressive periodontitis comprises a major scientific and clinical challenge. In recent years some evidence has been provided that bioactive glass is also capable of supporting the regenerative healing of periodontal lesions.

Objective

The aim of this clinical and radiological prospective study was to evaluate the efficacy of bioactive glass in the treatment of intra-bony defects in patients with localized aggressive periodontitis.

Methods

Twelve localized aggressive periodontitis patients with bilaterally located three-walled intra-bony defect depth ≥ 2 mm, preoperative probing depths ≥ 5 mm were randomly treated either with the bioactive glass or without the bioactive glass. The clinical parameters plaque index, gingival index, probing depth, gingival recession, clinical attachment level, and mobility were recorded prior to surgery as well as 12 months after surgery. Intraoral radiographs were digitized to evaluate the bone defect depth at baseline and 12 months after the surgery.

Results

After 12 months, a reduction in probing depth of 3.92 ± 0.313 mm ($P < 0.001$) and a gain in clinical attachment level of 4.42 ± 0.358 mm ($P < 0.001$) were registered in the test group. In the control group, a reduction in probing depth of 2.5 ± 0.230 mm ($P < 0.001$) and a gain in clinical attachment level of 2.58 ± 0.149 mm ($P < 0.001$) was recorded. Radiographically, the defects were found to be filled by 2.587 ± 0.218 mm ($P < 0.001$) in the test group and by 0.1792 ± 0.031 mm ($P < 0.001$) in the control group. Changes in gingival recession showed no significant differences.

Conclusion

Highly significant improvements in the parameters Probing depth, Clinical attachment level, and Bone defect depth were recorded after 12 months, with regenerative material.

KEYWORDS

Bioactive glass; periodontitis, aggressive/surgery

INTRODUCTION

Bone graft materials developed over the recent years have revolutionized the periodontal therapy in regenerating the lost periodontal tissues. Synthetically produced bioactive glass is osteo-conductive, biocompatible bone graft material.¹ The bioactive glass (PerioGlas, US Biomaterials, Alachua, FL.) used in the present study is a granulated

form of bioglass 45S5 and consists of 45.0% by weight of SiO_2 , 6.0% by weight of P_2O_5 , and 24.5% by weight of CaO and Na_2O , respectively. The granules have a grain size of 90 to 710 μm . After implantation, a time-dependent modification of the particle surface results in the formation of a hydroxyl carbonate apatite layer.² The aim of this

clinical and radiological prospective study was to evaluate the efficacy of bioactive glass in the treatment of intrabony defects in patients with localized aggressive periodontitis.

METHODS

The present investigation is a clinical and radiological prospective study. The study protocol is based on the guidelines of the Declaration of Helsinki (1964) of the World Medical Association (WMA), 1996 revised version.

Study Population

This was a randomized controlled clinical trial, with split-mouth design. Twelve patients (10 females, 2 males) between 18 and 25 years old with localized aggressive periodontitis were enrolled in the study from the Dept. of Periodontics, MNR Dental College, and Sangareddy in the year 2009. All patients first underwent periodontal pretreatment, concluded by recording clinical parameters and taking intraoral radiographs. All patients had a clinical attachment loss (≥ 4 mm) at more than six teeth. Each patient underwent periodontal pretreatment with systemic administration of Amoxicillin 250-500 mg (Novomox, cipla) eight hourly and with Metronidazole 200-400mg (Metrogyl) eight hourly for five days.³⁻⁶ Each patient underwent initial therapy with removal of supra and sub gingival plaque and elimination of cofactors (projecting filling margins, carious lesions, etc.). This was supplemented by thorough instruction and motivation aimed at effective oral hygiene. This initial treatment was completed at least eight weeks before surgical intervention.

Preoperative transgingival probing and radiographic findings revealed deep intrabony defects in all patients. The inclusion criteria were probing depths ≥ 5 mm preoperatively and three-walled osseous defects with a depth ≥ 2 mm intra-operatively. None of the defects showed furcation involvement at the time of surgery. During the surgical intervention, the extent and morphology of the defects were determined. The postoperative controls of the healing process were performed at short intervals. Irregularities in the healing process (graft exposure, inflammation, etc.) were documented at the follow-ups; tooth cleaning and, where applicable, patient remotivation, were carried out from the second week onwards. After 12 months the clinical parameters were recorded again, and radiographs of the treated teeth were taken at 12 months.

In total, 24 defects were selected randomly by coin toss process, of which 12 were with bioactive glass (PG) and 12 without Bioglass (RXT) material. The treated tooth surface (mesial or distal) was regarded as a single case for statistical purposes, resulting in a total of 24 defect surfaces (12 without bioglass, 12 with bioactive glass). Twenty four of these surfaces were located are three-walled osseous defects. Surgery was performed on 24 molar surfaces. The exclusion criteria were as follows: smoking (>5 cigarettes per day), medically compromised individuals, orthodontic

treatment (e.g. brackets), extensive carious lesions, medication in the six months preceding the study (e.g., immunosuppressive drugs), and psychiatric disorders. Very good oral hygiene with an approximal plaque index (API) $<15\%$ served as an additional inclusion criterion.

The interventions were performed under local anesthesia. An intrasulcular incision was first made, with care being taken not to damage the interdental papillae, and a muco-periosteal flap was then prepared. After removal of the granulation tissue and careful planing of the root surface with manual instruments and ultrasonic scalers, the defects were measured intra-operatively by the periodontist, with the depth (alveolar crest to defect base) and width (alveolar crest to root surface) of the defects and the number of bony walls being determined (Fig 1). Further procedure depended on the material used. In the PG group, the intrabony defect was filled with the bioactive glass granulate, to which 8 to 12 drops of 0.9% NaCl solution per cm had been added.³ After a mixing time of 10 to 15 seconds, the resulting cohesive mass was processed within two to three minutes (Fig. 2). In both groups, the muco-periosteal flap was then repositioned tension-free over the defect and sutured close to the bone and teeth with interrupted interdental sutures. The patients were advised to take Amoxicillin-250mg (Novomox, Cipla) eight hourly for five days and Combiflam eight hourly for three days. The patients were instructed to rinse the oral cavity twice a day with 0.2% chlorhexidine digluconate solution for two weeks. The sutures were removed between day 7 to 10 post surgery. Follow-up was then carried out weekly and at three months, six months, nine months and one year post-surgery. Plaque score, bleeding score, pocket depth (PD), clinical attachment level (CAL) and gingival recession (GR) were recorded at baseline and after one year. Standardized radiographs for image analysis were taken at baseline, immediately post-operatively and after one year.

The clinical parameters were recorded prior to surgery (baseline) and after 12 months using UNC-15mm probe (Hufriedy USA) at tooth surfaces (mesial or distal) with custom made acrylic stent on the tooth. The parameters recorded were: plaque index (PI),⁷ gingival index (GI),⁸ probing depth (PD), gingival recession (GR), clinical attachment level (CAL).

Periapical radiographs (Ektaspeed Plus, Eastman Kodak, Rochester, NY) using standardized paralleling technique (Intraos-70, Bluex (70KVP, 7 mA), Confident) with positioning aids (XCP Instrumentation Kit, Rinn, IL.) were taken immediately before surgery and after 12 months. After being developed the films were digitized using a miniature scanner with a local resolution of 500 dpi. The images were then measured linearly under 6.5 magnification on the computer monitor, using imaging software (XENON -2008, imaging software). Metric evaluation of the images was based on the following radiological landmarks (Fig. 3): The cemento-enamel junction was defined as the most apical point of the enamel at the proximal surface of the tooth on the defect side (xCEJ), the alveolar crest as the point on

the proximal surface of the defective tooth at which the projected alveolar crest intersects the root surface (xCA), and the defect base as the most coronally located point at the proximal surface of the tooth on the defect side up to which the periodontal ligament space still displays uniform width (xBD). The distance from alveolar crest to defect base is bone defect depth (xCA-xBD). Following calibration of the individual images by means of reference lines, the relative changes in the distances were computed.

The clinical and radiological data were evaluated using statistical software. The location parameters used were the arithmetic mean for the distributions and the standard deviation for the scatter of the individual results. The Mann-Whitney U test is to check for significant differences between preoperative parameters, and Wilcoxon's matched-pairs signed-ranks test to check for significance between paired variables. The significance level was set at $P \leq 0.05$.

RESULTS

All cases showed uneventful healing, in the course of the study. The baseline clinical parameters were comparable in both groups (Table 1). After 12 months, a significant improvement in PD and CAL over baseline findings was recorded in both groups.

Table 1. Comparison of Preoperative Clinical Parameters (mean \pm SD)

Parameter	PG(12)	RXT(12)	p
PI	0.383 \pm 0.083	0.433 \pm 0.107	P1=0.1711, p2=0.3421
GI	1.308 \pm 0.138	1.275 \pm 0.114	P1=0.2611, p2=0.5222
PD(mm)	7.33 \pm 1.07	6.92 \pm 1.31	0.4902
CAL(mm)	5.75 \pm 1.14	5.17 \pm 1.19	0.2983
GR(mm)	0.17 \pm 0.58	0	
BDD(mm)	4.516 \pm 0.916	3.756 \pm 1.059	0.126

P=Mann-Whitney U test

PI=Plaque index, GI=Gingival index, PD= Probing depth, GR=Gingival recession, CAL=Clinical attachment level, RXT= Contro site with only treatment group, PG= Test site with perioglass, BDD= Bone defect depth. PG = bioactive glass, RXT = without bioglass.

Table.2. Changes in Clinical and Radiological Parameters at 12 months (mean \pm SD)

Groups	Clinical changes(mm) 12 months		Radiological changes(mm) 12 months	
	Δ PD	Δ CAL	Δ GR	Δ BDD(mm)
PG (12)	3.92 \pm 0.313	4.42 \pm 0.358	0	2.587 \pm 0.218
RXT (12)	2.5 \pm 0.230	2.58 \pm 0.149	0	0.1792 \pm 0.031
p	0.0024	0.0024	--	0.0024

Δ =indicates changes in comparison to baseline findings

p=Wilcoxon signed-ranks test, PG=Test site with perioglass, RXT=Control site with only treatment group.

PG = bioactive glass, RXT = without bioglass.

After 12 months, a reduction in PD from 7.33 \pm 1.07 mm to 3.42 \pm 0.67 mm and 6.92 \pm 1.31mm to 4.42 \pm 0.67mm

was recorded in PG group and RXT group , respectively ($P = 0.001$). The residual PD was 3 mm in 66% of the cases, 4mm in 25% of cases, 5mm in one case; in the PG group and 3-4 mm in 50% of cases, 5mm in 50% of cases in RXT group (table 2).The CAL was reduced after 12 months from 5.75 \pm 1.14mm to 1.33 \pm 1.56 mm ($P = 0.001$) in the PG group and from 5.17 \pm 1.19 mm to 2.58 \pm 1.16 mm ($P = 0.001$) in the RXT group (table 2).

In both the groups, none of the cases showed gingival recession either preoperatively or Postoperatively except in one case (PG Δ group) which showed 2mm gingival recession at baseline and after 12months.

Analysis of the radiological parameters revealed a reduction in defect depth (xCA-xBD) of 2.587 \pm 0.218mm ($P = 0.001$) in the PG group and of 0.1792 \pm 0.031mm ($P = 0.001$) in the RXT group (Table 2).

DISCUSSION

This study evaluated the response of periodontal osseous defects treated by flap debridement with and without the implantation of a bioactive glass. Mean gain in clinical attachment level and probing depth reduction was significantly better in the bioactive glass sites (PG) than in the control (RXT) 12 months post-surgery. All clinical parameters measured at 12 months post surgery demonstrated significantly better results in the graft treated sites (PG). This was evident 12 months post surgery, where gain in clinical attachment levels (4.42 \pm 0.358 versus 2.58 \pm 0.149 mm) and probing depth reduction (3.92 \pm 0.313 mm versus 2.5 \pm 0.230 mm) showed a statistically significant difference between test (PG) and control sites (RXT), respectively. The gain in CAL and reduction in PD were more in this study when compared with Zamet et al.(CAL=2.7 mm, PD=3.7mm) and Froum et al. (CAL=3.0 mm, PD=4.4mm) probably due to pretreatment with systemic administration of Amoxicillin (250-500mg tid) and Metronidazole (200-400mg tid) for five days.^{9,10} Buchmann R, et al., Walker C, et al., Guerrero A, et al., Doğan Kaner et al., had demonstrated significant improvement in reduction of PD, gain in CAL and to target the specific bacteria in AP with the systemic administration of Amoxicillin and Metronidazole.³⁻⁶

The significant reduction in bone defect depth and defect area was observed in test sites when compared with control sites which were radiologically evaluated using Xenon imaging software. Zamet et al. provided radiological confirmation of this difference from flap surgery alone by means of CADIA.⁹

In the present study Perioglas was used in test sites as bone replacement material, with a particle size of 90-710 μ m, which showed greater improvement in test sites compared to control sites, all parameters are in good conformity with the studies conducted by Zamet et al. and Reiner Mengel et al.^{9,11,12}

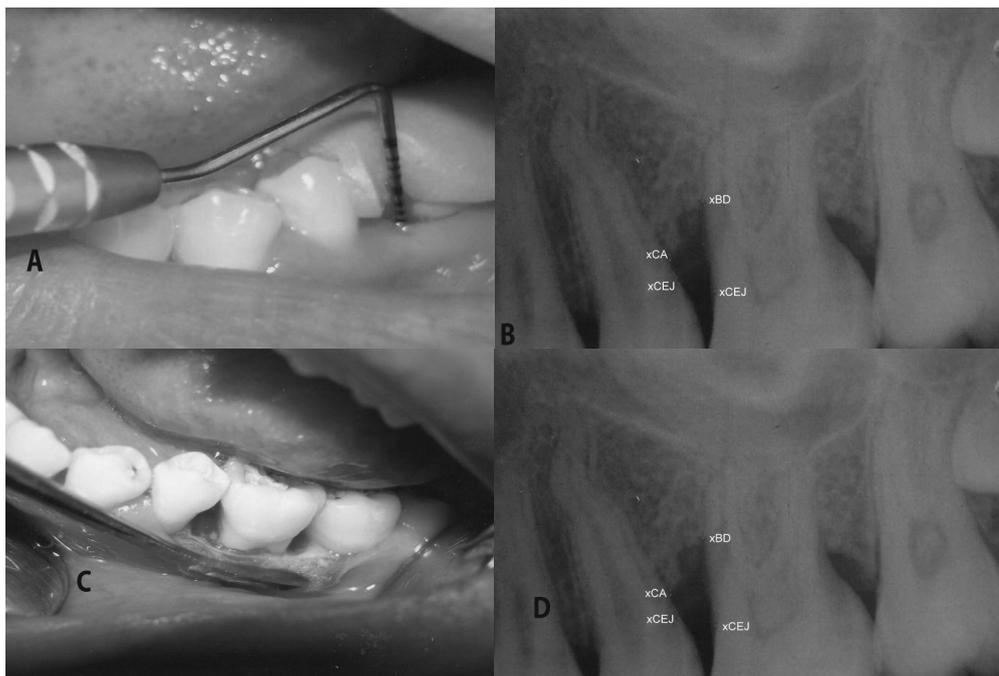


Figure 1. Treatment in RXT GROUP. (A, B. Prior to surgery, C. After raising the muco-periosteal flap, D. 12 months post-surgery.)



Figure 2. Clinical application of Bioglass. (E, F. Prior to surgery, G. After raising the muco-periosteal flap, H. After implanting bioglas, I. 12 month post-surgery)



Figure 3. Radiological land marks

Park JS et al. examined the effectiveness of bioactive glass with particle size of 300-355µm (Biogran) in flap operations and concluded that use of bioglass significantly improved PD, CAL & Bone probing depth.¹³ Wheeler DL et al. compared Perioglas (90-710µm) and Biogran (300-355µm) histologically in cancellous defects of rabbits and concluded more bone was quantified with Perioglas than Biogran.¹⁴ According to Hench et al. dissolution rate of Bioglass would be affected by ratio between surface area and solution volume.² Dissolution rate was found to be inversely proportional to radius of the particle, where as nucleation and growth of HCA occurred earlier on surfaces with a larger radius of curvature. Smaller particles exhibit rapid dissolution, better resorbability and thin HCA

formation; it's vice versa for larger particles.

According to Lovelace et al bioactive glass is capable of producing results in the short term (six months) similar to that of DFDBA ,when used in moderate to deep intrabony periodontal defects.¹⁵

At this instance, the regenerative healing of periodontal lesions after application of bioactive glass was histologically examined in animals by Wilson and Low, Karatzas et al. reported the new cementum formation with collagen fiber insertion, and no long junctional epithelium at the bioactive glass site.^{16,17}

In contrary to the above studies, Nevins ML, et al. evaluated Bioglass histologically in five human periodontal defects, and confirmed the new formation of root cementum and connective tissue attachment at only one tooth.¹⁸ There are currently limited studies available comparing the treatment outcomes of bioactive glass in the treatment of intrabony defects in aggressive periodontitis. The present study

was carried out for 12 months, but the long term follow up is required for further confirmation of the efficacy of Perioglas in aggressive periodontitis. The present study was based on only clinical & radiological observations; however surgical reentry and histological evidence are necessary to support the findings

CONCLUSION

The results showed reduction in probing depth, gain in clinical attachment level, and reduction in defect depth in both the groups but the significant improvement was observed in test group rather than in control group

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