Review Article

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Bioactive Glass: The Next Paradigm of Synthetic Bone Graft Materials

Sanjay Kumar Sahoo[1] Krishnam Raju[2] Dhirendra Kumar Singh[3*]

[1]PG Student, Department of Periodontology and Oral Implantology, Kalinga Institute of Dental Sciences, KIIT University, Bhubaneswar, Odisha, India.

[2]Professor, Department of Periodontology and Oral Implantology, Kalinga Institute of Dental Sciences, KIIT University, Bhubaneswar, Odisha, India.

[3]Reader, Department of Periodontology and Oral Implantology, Kalinga Institute of Dental Sciences, KIIT University, Bhubaneswar, Odisha, India.

ABSTRACT

Background: Bioactive glass is introduced as a synthetic bone graft substitute in various periodontal osseous defects. This review paper provides an overview of the previous published clinical researches on indications such as deep intra-osseous defects i.e. horizontal bone resorption, vertical bone resorption **&** destructive periodontal disease who were got treated with bioactive glass material which will definitely enhance the apprehensive knowledge of reader about bioactive glass as synthetic bone graft material.

Keywords: Bioactive glass, Bone graft, Osseous defects, Periodontal regeneration.

INTRODUCTION

The regeneration of osseous defects caused by inflammatory periodontal disease continues to provide an ongoing challenge in periodontal therapy[1]. The retention of teeth with severe osseous defects remains a problem in the practice of Periodontics[2]. Deep intraosseous defects represent a major challenge for the clinician. Sites with lesions have been shown to be at a high risk of disease progression in subjects who had not received periodontal therapy[3]. During destructive periodontal disease, connective tissue attachment of the tooth to the bone is reduced and alveolar bone is resorbed ultimately .Periodontal diseases are a major cause of tooth mobility and tooth loss in adults. In the overall evolution of periodontal therapy, initial attention focused upon the arrest of disease and long term maintenance of dentition[4]. A long term goal of periodontal therapy is to regenerate the periodontium to its prediseased state. To achieve this goal, periodontal surgical procedures are frequently required in order to repair or regenerate lost periodontium[15]. Periodontal surgical procedures have focused on the elimination of hard and soft tissue defects (i.e. probing depths and osseous defects) by regenerating new attachment. This new attachment ideally consists of new bone, cementum, and attached periodontal ligament to replace that which was lost due to periodontal disease[5].

Regeneration has been defined as the reproduction or reconstitution of a lost or injured part to restore the architecture and function of the periodontium. Historically, procedures used to treat diseased sites have included scaling, root planning, gingival curettage and flap surgery. There were remarkable reductions in pocket depth, as healing takes place by

1) Tissue shrinkage

2) Long junctional epithelium which is a weak joint and vulnerable for recurrence.

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***Correspondence Dr. Dhirendra Kumar Singh.**

Department of Periodontology and Oral Implantology, Kalinga Institute of Dental Sciences, KIIT University, Bhubaneswar, Odisha, India.

Email: dr.dhirendra27@gmail.com

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Complete regeneration of such lost tissue has still remained a mirage. Over the years different efforts have been carried out to this effect. Bone grafting is the most common form of regenerative therapy and is usually essential for restoring all types of periodontal supporting tissue (Archelmann Reidy & Yukna, 1998). The first recorded attempts to use bone graft was by the Dutch surgeon, Job Van Meekren in 1668. However the first use of bone grafts in periodontal therapy is credited to Hegedus in 1923[6].

A bone graft is a bone void filler material that is used in a surgical procedure to replace missing bone. It can be a material from the patient's own body (autogenous bone) or an artificial, synthetic, or natural substitute. The graft not only replaces missing bone, but also helps the body to regrow its own lost bone. This new bone growth strengthens the grafted area by forming a bridge between the existing bone and the graft material. Over time one's own newly formed bone will replace much of the grafted material.

Bone grafts are needed when a portion of bone is missing which is frequently called a "bony defect". Among treatment modalities, grafting of biomaterials and application of biological agents have been used with varying success during the past decade to accomplish the reconstruction of lost attachment apparatus in deep intraosseous defects. Recently a variety of alloplastic materials have been introduced and utilized in periodontal therapy. These materials are most commonly made from Hydroxyapatite, Beta-Tricalcium phosphate or Acrylic polymer. They offer the advantages of unlimited quantity, no additional surgical site, and no potential to disease transmission. Use of newer material, bioactive glass, and hard tissue polymers has more new attachment and bone fill.

Bioactive glass is a non resorbable material. Research into Bioactive glass began with applications toward use in orthopedics. Bioactive glass is now clinically approved for use in dense form in non-load-bearing applications such as middle ear prostheses and endosseous ridge implants and as a particulate for periodontal defect repair. Studies indicates that bioactive glass has potential as a bone replacement graft material and is effective as an adjunct to conventional surgery in treatment of intrabony defects. With the help of available literatures, an attempt has been made in this review to evaluate the efficacy and efficiency of Bioactive glass as bone grafting material. Periodontal disease alters the morphologic features of bone, in addition to reducing bone height. Different patterns of bone destruction such as horizontal or vertical can be produced by periodontal disease.

World Workshop in Periodontics of the American Society of Periodontology in 1966 had categorized bone defects as:

Horizontal bone resorption- Resorption of alveolar bone occurs to the same degree all around the circumference of a tooth.

Vertical bone resorption- Resorption occurs to different extents at different points around the circumference of a tooth. This type of resorption results in the formation of bony "niches" on one or more sides of tooth. Bony defects of this type have been referred to in the past as "infrabony defects". Later it was termed as "intrabony defects" or "intraosseous defects" indicating that this lesion is within the bone.

EM Eley[7] reported that the number of vertical defects increased with age, but was independent of race or sex. The number of intrabony defects was greater in the mandible than in maxilla.

Use of bone grafts in regeneration of lost bone aims at restoring function, in optimum health and esthetics. On its placement in the periodontal defect, osseous graft may

1. Act as a space filler thereby reducing the volume of blood clot.

2. Support the soft tissue walls of the periodontal defects- the "roof" of large volume three wall defects or lateral walls of combination defects.

Reynolds and colleagues (2003), in their meta-analysis of bone replacement grafts in the treatment of intrabony defects from 1966-2002, and the American Association of Periodontology position paper on periodontal regeneration (2005) agreed that bone grafts[7].

a) Increase the bone level

b) Reduce crestal bone loss
c) Increase the clinical attachment level
d) Reduce probing pocket depth when compared with open flap surgery
e) Increase clinical attachment level and reduce probing depth when combined with guided tissue regeneration compared with graft alone.
f) Support formation of new attachment apparatus

Definition of various bone grafting terms - According to Steven Garnet[8]

World Workshop in Periodontics 1989 and AAP glossary of terms (2001).

Repair- Healing of a wound by tissue that does not fully restore the architecture and/or function of the part, as in case of the long junctional epithelium or ankylosis.

Regeneration- The replacement of injured cells by cells of the same type, sometimes leaving no residual trace of the previous injury. It can also be defined as reproduction or reconstruction of lost or injured parts by restoration of new bone, cementum and periodontal ligament (reunion of connective tissue) or an unhealthy or previously diseased root surface. Ideally complete restoration would also restore total function.

Reattachment- the reunion of connective tissue with healthy root surface on which viable periodontal tissue is present without new cementum as in case of trauma, after supracrestal fibrotomy or reentry following flap surgery.

New attachment- is embedding of new periodontal ligament fibers into new cementum and attachment of gingival epithelium to tooth surface previously denuded by disease. It is also defined as the reunion of connective tissue with unhealthy or previously diseased root surface that has been deprived of periodontal ligament. This union occurs through formation of new cementum with inserting collagen fibers as in case of GTR.

Bone fill- Bone fill is defined as the clinical restoration of bone tissue in a treated periodontal defect. This term does not address the presence or absence of periodontal regeneration or a new connective tissue attachment.

Linkage- is the reunion of connective tissue with an unhealthy or previously diseased root surface without new cementum. This is thought to occur after root demineralization.

Carranza FA[9,10] described different types of bone and notable bone graft materials and classified them as follows.

A. **Autogenous bone grafts**- *Autogenous bone* grafts are taken from one part of a patient's body and transferred to another. Autogenous bone can be obtained from an intraoral or extraoral source. Common intraoral sites for socket grafting include the mandibular symphysis, mandibular ramus, and maxillary tuberosity. The advantages of autogenous bone grafts are that it is has an osteogenic potential and a high predictability, with disadvantages being the need for a second surgical site, possible postoperative discomfort or complications, and potential limitations on the amount of graft material that can be harvested. Autogenous bone graft includes cortical bone chip, osseous coagulum, bone blend, extraction socket bone and extraoral cancellous bone with marrow.

B. **Allografts**- Allografts are grafts transferred between genetically dissimilar members of the same species. Allograft bone has been used extensively in dentistry for more than 2 decades. These advantages include ease of handling, increased containment in the graft site, and an increase in the osteoinductive effect. Two types of bone allograft materials, are used presently viz, Decalcified freeze dried bone allograft and Freeze dried bone allograft C. **Xenografts**-It is an osseous tissue that is harvested from one species, processed and then transferred to a recipient site of a different species. If properly prepared it is well tolerated by the tissue. It involves the risk of autoimmune disease. For oral application, it generally comes in a granular or powder form. An example is graft materials derived from a bovine source. It is available in various particulate sizes. These grafts are osteoconductive, without having any osteoinductive properties. These grafts create a biocompatible scaffold. Mainly Keil bone, Calf bone (Boplant) and Anorganic bone are used.

D. **Non bone graft materials**- Alloplastic materials are synthetic products, and include ceramic and acrylic materials. They are osteoconductive only.

They eliminate the risk of disease transfer and procurement morbidity and it is abundantly available. The synthetic materials can be classified by their ability to be bioabsorbed. The absorbable materials include ceramics, beta-tricalcium phosphate, Hydroxyapatite, Calcium sulphate and Calcium carbonate. The non-absorbable materials include porous hydroxyapatite, dense hydroxyapatite, bioglass and calcium coated polymer of hydroxyethylmethacrylate and polymethylmethacrylate. An ideal bone replacement graft should be able to trigger osteogenesis, cementogenesis and formation of periodontal ligament through:

1. Osteogenic activity- refers to bone formation by living cells, which differentiate into mature osteoblasts under appropriate stimulation. Cells with osteogenic potential include osteoblasts and undifferentiated osteoblastic stem cells.

2. Osteoinductive activity- Osteoinductive activity refers to the property of some substances to induce differentiation towards an osteoblastic phenotype. The term osteoinduction has been used to refer to the in vivo action of some peptide growth factors which may initiate or promote the cascade of events that leads to the transformation of pleuripotent stem cell to mature osteoblasts and eventually bone formation.

3. Osteoconductive activity- Osteoconductive activity refers to the property of a material to promote the distribution of a bone healing response throughout the defined volume. The function is analogous to a scaffold or framework on which bone healing response is facilitated. For bone grafting to be successful, osteogenic activity and bone formation alone are not sufficient. Newly formed bone must be distributed effectively in the grafted volume and must unite with local skeleton.

Schallhorn (1977)[11] defined the consideration that governs the selection of graft materials. They include:

1. Biologic acceptability
2. Non-carcinogenic
3. Predictability
4. Clinical feasibility
5. Minimal operative hazards
6. Minimal post-operative sequelae
7. Easily obtainable
8. Relatively inexpensive
9. Patient acceptance

Gross 1997 also outlined the ideal characteristics of bone substitutes. They are[12]:

a) Biocompatibility
b) Serve as a scaffold for new bone formation
c) Resorbable in long term and have the potential for replacement of host bone.
d) Osteogenic or at least facilitate new bone formation
e) Radio opaque
f) Easy to manipulate
g) Do not support growth or oral pathogens
h) Hydrophilic
i) Available in particulate and molder forms
j) Microporous
k) Ease of availability
l) Non-allergenic
m) Act as a matrix or vehicle for other materials
n) Have high compressive strength
o) Should be effective in GTR procedure

It is difficult to find a material with all these characteristics and to date there is no ideal material or technique available. Schallhorn (1979)[13] suggested various factors that influence bone regeneration. He categorized them as "Major Determinants" and "Minor Determinants".

Major Determinants:

1. Patient selection
2. Morphology of defects
3. Nature of preparation
4. Types of graft used
5. Plaque control effectiveness of the patient
6. Repair potential of the patient.
7. Periodontal maintenance program followed

Minor Determinants:

Are important but not of critical importance. They include.

1. Types of surgical flap
2. Placement of graft
3. Use of epithelial retardation technique
4. Occlusal consideration
5. Tooth mobility
6. Suture technique

7. Degree of flap closure
8. Use of antibiotics during postoperative phase.

STEPS OF BONE GRAFT TECHNIQUE:

1. Remove all etiological factors
2. Stabilize teeth if necessary
3. Flap design with a plan for closure
4. Degranulation of defect and flap
5. Root preparation
6. Encourage a bleeding bony surface
7. Presuturing
8. Condense graft material well up to realistic level
9. Good tissue coverage
10. Place periodontal pack
11. Prescribed antibiotics
12. Postsurgical care

PERIOGLAS:

Perioglas (Bioglas synthetic bone graft particulate) is a bioactive glass material used for alloplastic bone grafting. Perioglas is composed of elements naturally occurring in bone (Ca, Na, Si, P, and O). The particle size of this material ranges from 90-710 microns. Bioactive glass has the ability to bond to both hard and soft tissue. The composition bioactive glass particles is

Silicon dioxide (46 mole %), Sodium oxide (24. 4 mole %), Calcium oxide (26mole %), and Phosphorous pentoxide (6 mole %). When the material comes in contact with body fluids a unique surface reaction (time dependent kinetic modification) occurs within minutes of implantation. Initially there is an ionic exchange whereby the cations are leached from the surface of the material in exchange for hyrodonium or hydrogen ions forming silanol groups (SiOH). This ion exchange process leads to an increase in interfacial pH. Silanol groups bond to adjacent silanol groups through a polycondensation reaction forming a silica-rich gel layer on the particle surface. Silica plays a key role in developing the bone bonding of bioactive glasses. The silica rich gel has a high surface area which creates a site for the redeposition of calcium and phosphorous from the material and blood. Within hours a calcium phosphorous layer forms on top of the silica gel layer. Initially this calcium phosphate layer is amorphous because it is thin, but in time as the layer builds up in thickness and size crystallinity is detected, it becomes a crystalline hydroxycarbonate apatite (HCA) layer which is identical to bone mineral. This apatite layer provides the basis for the bonding of bone and the material. For a bond with tissue to occur, a layer of biologically active HCA layer must form. This surface reaction occurs until all of the ions in the internal part of the glass have undergone ionic exchange and ultimately the HCA layer becomes remodeled and incorporated into the bone. This bioactive glass named PerioGlas®, or previously named Bioglass has been used in both orthopedic and plastic surgery. Perioglas has also been shown to be haemostatic in both animals and clinical studies. While this effect appears to be mechanical, the result is a material that is easy to manipulate, does not migrate from the surgical site and has excellent adaptation to the defect. Perioglas is partially radiopaque, which enables the clinician to make immediate, as well as long term, postoperative evaluation.

Histological overview:

Wilson and Samuel B. Low, 1992[14] Studied in a Patus monkey surgical model, the clinical and histologic repair response of 45S5 bioactive glass, dense HA, tricalcium phosphate, and open debridement. Two walled defects were surgically created. The animals were sacrificed at 1, 4, and 6 months. In the bioactive glass implanted sites no new attachment were seen at 1 month and particles were present in the defects surrounded by connective tissue. At 9 months, the bioactive glass particles were seen within the bone and the junctional epithelium was close to the original level. The HA and tricalcium phosphate sites showed more junctional epithelium migration. The HA particles were not consolidated and were embedded in connective tissue. They also found bioactive glass to be easier to handle and manipulate due to the haemostatic effect of this material in the surgical defect area.

Hironobu Oonishi et al, 1995[15]. Studied bioactive glass, 45S5 Bioglass, in comparison with HA in an animal model to discover whether the 2 major disadvantages of HA may be overcome such as difficulty of placing and retaining the particulate in the defect and the length of time needed before full bony restoration is achieved. Results from this

study suggest that Bioglas particles overcome both of these disadvantages of HA. The particles were packed easily into the defects because of the formation of a cohesive mass of gel layer that formed on the surface of Bioglass in contact with moisture and the haemostatic effect of this material were also observed. Secondly full restorations of bone were observed in 2 weeks, rather than the 12 weeks needed for the particulate hydroxyapatite to produce a comparable response. New trabecular bone was present at the center of the defect at 3 weeks in the Bioglas-filled defect, while only half that distance was covered in the HA-filled defect.

Michael W Johnson, 1997[16] did a research to determine the PerioGlas® interface with titanium dental implants and bone. Two implants in each rabbit had a surgically created defect adjacent to one side of the coronal aspect of the implant. The defect was filled with PerioGlas®. The rabbits were sacrificed at 1, 2, 3, 6, 12, and 24 weeks. Histological observation demonstrated formation of osteoid, followed by bone deposition within the defect from host (surgical margin) bone, toward the implant in the PerioGlas®-filled defect. New osteoid and bone formed around the PerioGlas® particles. In the 1-, 2-, and 3-week specimens, significantly more bone appeared to be formed in the test sites than in the unfilled control sites. The new bone appeared to reach the implant at an accelerated rate, as compared to the unfilled defect. The implants that incorporated PerioGlas® particles osseointegrated within the dense bone. The particles seemed to act as stepping stones for new bone formation.

Cary A Shapoff, et al (1997)[17] presented a case report evidence of 37 sites utilizing bioactive glass, bioactive glass and autogenous bone, and bioactive glass and decalcified freeze-dried bone. Very similar results were achieved whether bioactive glass was applied alone or in combination with autogenous bone or DFDBA. The authors reported a 6-month mean probing depth reduction of 53%, 57%, and 53%, respectively and mean gains in probing attachment level of 5.3mm, 4.8mm, and 5.6mm. No re-entries or controls were included in the results. Radiographic observations revealed an initial increase in radiolucency of the graft material at early 0-4 months. Thereafter, a steady increase in opacity was observed, with the most significant changes noted after 6 months. After 6 to 8 months, it was difficult to distinguish the bioglass from the surrounding alveolar bone, and the appearance a bony trabecular pattern was observed in the densely mineralized graft site.

Daniela Cristina Joannitti Cancian **2008**[18] evaluated the histologic results of bone cavities that were surgically created in the mandibles of Cebus apella monkeys filled with autogenous bone, Perioglas, Filler Bone, or Bone Source. Surgical cavities 5 mm in diameter were prepared through both mandibular cortices in the mandibular angle region. The cavities were randomly filled, and the animals were divided into groups according to the material employed: Group 1 cavities were filled with autogenous corticocancellous bone; group 2 cavities were filled with calcium phosphate cement (Bone Source); and group 3 and group 4 cavities were filled with bioactive glass (Filler Bone and Perioglas, respectively). After 180 days the animals were sacrificed, and specimens were prepared following routine laboratory procedures for hematoxylin/eosin staining and histologic evaluation. The histologic analysis showed that autogenous bone allowed total repair of the bone defects; bioactive glasses (Filler Bone and Perioglas) allowed total repair of the defects with intimate contact of the remaining granules and newly formed bone; and the cavities filled with calcium phosphate cement (Bone Source) were generally filled by connective fibrous tissue, and the material was almost totally resorbed. They concluded that autogenous bone is the best choice for filling critical-size defects. Synthetic implanted materials demonstrated biocompatibility, but the Bioglas demonstrated osteoconductive activity that did not occur with calcium phosphate (Bone-Source). The Perioglas was mostly resorbed and replaced by bone and the remaining granules were in close contact with bone; the FillerBone showed many granules in contact with the newly formed bone; Bone Source did not permit repair of the critical-size defects, and the defects were generally filled by connective fibrous tissue.

Clinical overview:

William Becker et al (1986)[19] treated fourteen defects with flap debridement procedures using the Prichard principle of epithelial exclusion. Six defects were considered to be medium in width (3-4 mm),

seven defects were wide (>4 mm), and one defect was narrow (1-2 mm). The parameters studied were changes in gingival and plaque scores, attachment levels, and bone scores. All defects were reentered 9 to 16 months after surgery and changes between the pretreatment and post treatment bone levels were recorded. The mean gain in probing attachment level was 2.76 mm. The mean amount of defect fill measured from models was 2.56 mm, while the mean defect fill from direct measurements was 3.26 mm. The percentage defect fill measured from study models was 61%. Crestal resorption was 9.7%. The average change in defect volume unadjusted for crestal resorption was 61.8 cu mm. Seven defects had a 50% or greater decrease in defect volume, while seven defects had less than a 50% change. Intrabony defects where calculus is present on the involved tooth surface prior to therapy will repair with substantial amounts of bone as a result of open debridement.

Zamet, et al 1997[20] compared bioactive glass and open flap debridement in the treatment of 44 periodontal intrabony defects in 20 patients. They measured plaque scores, bleeding scores, probing depth (PD) and clinical attachment level (CAL) at baseline, 3, 6, 9, and 12 months post-surgery. Standardized radiographs for computer-assisted densitometric image analysis (CADIA) were taken at baseline, immediately post-operatively and at 1 year. The authors reported that PD and CAL showed significant improvement in the experimental and control sites with a greater trend to improvement in the experimental sites. A significant increase was reported in the radiographic density and volume in favor of the bioactive glass treated sites when compared with the open debridement treated sites with CADIA analysis. No surgical re-entries were performed.

Oonish et al 1997[21] did a study where they compared bioactive glass to hydroxyapatite and found that bioactive glass was easy to manipulate and haemostatic and allowed full restoration of bone in 2 weeks compared to 12 weeks needed for HA to produce a comparable response. The Bioactive material is used up in the process and any problems associated with the production of a composite of bone and biomaterials are avoided in the fully restored bone.

John M. Schmitt et al 1997[22] compared bone regeneration promoted by porous bone mineral and biologically active glass. Unilateral critical-sized defects (CSDs) were prepared in the radii of 24 rabbits, divided evenly between 2 time periods (4 and 8 weeks) and between 2 treatment groups (porous bone mineral and biologically active glass). Evaluations consisted of clinical examinations, standardized radiography at baseline and every 2 weeks thereafter, as well as histology and histomorphometrically. Data were analyzed by an unpaired Student t-test with significance established at $P < 0.05$. They determined that CSDs treated with porous bone mineral were significantly more radiopaque than biologically active glass-treated sites at both 4 and 8 weeks. Moreover, the amount of new bone was significantly greater at both 4 and 8 weeks in the porous bone mineral groups than in the biologically active glass groups. They concluded that in the rabbit radius CSD wound model, porous bone mineral appeared to be more effective than biologically active glass in regenerating bone.

Hironobu Oonishi H **et al 1995**[23] compared bioactive glass, 45S5 Bioglass, with hydroxyapatite in an animal model to discover whether the 2 major disadvantages of hydroxyapatite such as difficulty of placing and retaining the particulate in the defect and the length of time needed before full bony restoration is achieved. Bioglass is shown to be easy to manipulate and haemostatic and allows full restoration of bone in 2 weeks, rather than the 12 weeks needed for the particulate hydroxyapatite to produce a comparable response.

Stuart J. Froum et al 1998[24] compared the repair response of bioactive glass synthetic bone graft particles and open debridement in the treatment of human periodontal osseous defects. Fifty-nine defects in 16 healthy adults were selected. Each patient had at least 2 sites with attachment loss of at least 6 mm with clinical and radiographic evidence of intrabony or furcation defects. One to 3 months after cause-related therapy (oral hygiene instructions, scaling and root planing), the following measurements were recorded prior to surgery: probing depths, clinical attachment level, and gingival recession. Each defect was surgically exposed and measurements made of the alveolar crest height and base of osseous defect. The test

defects were implanted with bioactive glass. The other sites served as unimplanted controls. Flaps were sutured at or close to the presurgical level. Radiographs and soft tissue presurgical measurements were repeated at 6, 9, and 12 months. At 12 months all sites were surgically re-entered to record osseous measurements. At the 12-month evaluation, significantly greater mean probing depth reduction was noted in the bioactive glass group compared to the controls (4.26 mm versus 3.44 mm; P = 0.028). Clinical attachment level gain was significantly improved (P = 0.0004) in the bioactive glass sites (2.96 mm) compared to the control sites (1.54 mm). There was significantly less gingival recession in the bioactive glass sites (1.29 mm) compared to the control sites (1.87 mm). Defect fill was significantly greater in the bioactive glass sites (3.28 mm) compared to the control sites (1.45 mm). Defect depth reduction was significantly greater in the bioactive glass sites (4.36 mm) compared to the control sites (3.15 mm). In conclusion, bioactive glass showed significant improvement in clinical parameters compared to open flap debridement

Teri Brooks Lovelace et al 1998[25] compared the use of bioactive glass to demineralized freeze-dried bone allograft (DFDBA) in the treatment of human periodontal osseous defects. Fifteen systemically healthy patients (6 males and 9 females, aged 30 to 63) with moderate to advanced adult periodontitis were selected for the study. All patients underwent initial therapy, which included scaling and root planing, oral hygiene instruction, and an occlusal adjustment when indicated, followed by re-evaluation 4 to 6 weeks later. Paired osseous defects in each subject were randomly selected to receive grafts of bioactive glass or DFDBA. Both soft and hard tissue measurements were taken at the day of surgery (baseline) and at the 6-month re-entry surgery. The clinical examiner was calibrated and blinded to the surgical procedures, while the surgeon was masked to the clinical measurements. Statistical analysis was performed by using the paired Student's t test. The results indicated that probing depths were reduced by 3.07 ± 0.80 mm with the bioactive glass and 2.60 ± 1.40 mm with DFDBA. Sites grafted with bioactive glass resulted in 2.27 ± 0.88 mm attachment level gain, while sites grafted with DFDBA had a 1.93 ± 1.33 mm gain in attachment. Bioactive glass sites displayed 0.53 ± 0.64 mm of crestal resorption and 2.73 mm bone fill. DFDBA-grafted sites experienced 0.80 ± 0.56 mm of crestal resorption and 2.80 mm defect fill. The use of bioactive glass resulted in 61.8% bone fill and 73.33% defect resolution. DFDBA-grafted defects showed similar results, with 62.5% bone fill and 80.87% defect resolution. Both treatments provided soft and hard tissue improvements when compared to baseline (P < 0.0001). No statistical difference was found when comparing bioactive glass to DFDBA; however, studies with larger sample sizes may reveal true differences between the materials. This study suggests that bioactive glass is capable of producing results in the short term (6 months) similar to that of DFDBA when used in moderate to deep intrabony periodontal defects.

Marianne MA Ong et al 1998[26] evaluated the use of bioactive glass (BG) for repairing/regenerating periodontal intrabony defects. Fourteen systemically healthy patients participated. Each patient had 2 contralateral sites with ^{3} 6 mm clinical probing depth and radiographic evidence of an intrabony defect. One defect was treated with flap debridement plus BG (test) and the other with flap debridement alone (control). Baseline measurements included gingival index (GI), plaque index (PI), position of the free gingival margin (S/FGM), clinical attachment level (CAL), probing depth (PD), and mobility. At the time of surgery and at surgical reentry (9 to 13 months later), hard tissue measurements included: stent to defect base, bone crest to defect base, and defect width at the bone crest. One-way repeated ANOVA was used to analyze the treatment effect. Friedman's test was used to detect any significant changes of GI, PI and mobility at different time periods (baseline, 3 months, 6 months, and reentry). For multivariate analysis, the random coefficients mixed effect model was applied to adjust the intra-correlation effect. Both treatments resulted in decreased PD and gain of CAL. These changes were only significant (P < 0.05) for the BG treated sites (PD reduction = 1.24 ± 0.43 mm, CAL gain = 0.87 ± 0.38 mm) from baseline. Defect fill was significant for test (1.1 ± 0.4 mm) and control (1.4 ± 0.4 mm) alike (P < 0.01). Although BG treated sites had more PD reduction and CAL gain than debridement only controls, there were no statistically significant differences between groups for any parameter measured. Further studies are

required to clarify the beneficial effects, if any, of BG alloplast in treating periodontal intrabony defects.

DISCUSSION

The conservation and preservation of dentition in a functional state has been the main goal of dentistry. Periodontal therapy is directed not only at inflammation control but also at pocket reduction and correction of associated bone defects. When applicable, regeneration of the lost bone and periodontal attachment improves the support of the teeth and its long term prognosis. Bone grafts are one of the regenerative techniques which have been used to achieve this end.

In the present review more than hundred articles were reviewed meticulously to find out the effectiveness of bioactive-glass as synthetic bone graft material and we found that Bioactive glass materials are well effective in various periodontal bone defects and provides very good bone fill and re bone formation but at the same time when it got compared with other available synthetic bone grafting materials like hydroxyapatite and tricalcium phosphate, studies showed somewhat similar results with Bioactive glass, accept the clinical attachment gain level which was always higher in the subjects who got treated with bioactive-glass material.[24, 27]

CONCLUSION

This literature review provides evidence that bioactive glass can be an effective synthetic bone graft material treatment of bone defects in various clinical situations. Long-term follow-up studies reported excellent results. In the view of previous clinical findings it can be concluded that Bioactive glass materials are good for treating periodontal defects. It provides greater bone fill and also reduce more pocket depth and improve gain in clinical attachment level. No doubt in this review paper some more studies on PerioGlas should have been included to prove its clinical feasibility. We cannot bypass one more fact that this material is very much expensive in comparison to other synthetic bone graft material.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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