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Research Article

Evaluation and Comparison of Osteoinductive and Osteoconductive Bone Replacement Implant Materials in Treatment of Human Periodontal Osseous Defects. (A Clinical Controlled Study)

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Abstract

A Study was done to evaluate and compare clinically, soft tissue changes on implanting of bone substitutes i.e. DFDBA (De-calcified freeze Dried Bone allografts) and Osteogen (RA resorb) in predominantly horizontal defects associated with prognostically hopeless teeth in contrast to conventional treatment for same osseous defects.

A total of 14 patients were recruited for the study spanning over 9 months and subjects were briefed about the rigorous protocol of study and informed consent was taken. After completion of Phase-I therapy and demonstration of acceptable oral hygiene by patients, baseline examination was carried out. Soft tissue assessments were done followed by the surgical procedure i.e. open flap curettage.

The post-operative assessment was done first at 3 months to evaluate the soft tissue response to treatment. Finally, after a span of 9 months, soft tissue assessments were made.

Keywords: Osteoinductive; Osteoconductive Bone Replacement; Implant; Human Periodontal Osseous Defects; DFDBA (De-Calcified Freeze Dried Bone Allografts)

Introduction

Since the advent of implants as a highly successful treatment for replacement of missing teeth the focus from regeneration of lost periodontal tissue in compromised teeth with osseous defects has taken a back seat.

It is apparent that, if the goal of periodontal regeneration needs to be realized, the problem of regeneration needs to be approached from a basic biological perspective. The periodontium consists of a cell and tissue complex organized spatially into the basic components of cementum, periodontal ligament and alveolar bone. The challenge of regeneration is to reconstitute the complex onto a root surface that is the site of marginal periodontitis [30]. The hard and soft tissue destruction ensues with the attendant periodontal disease [34]. The need to restore osseous defects attendant to the disease has been a continual theme of periodontology. The holy grail of periodontitis has always been the restoration of the destroyed periodontium by new bone, periodontal ligament, and cementum as well as their 'recreation in 'normal anatomic relationship and function [11]. Considerable emphasis has been placed on bone graft procedures since it offers a more desirable approach to the correction of the bony lesion. Ample histologic evidence is available of periodontal reconstruction in humans including new cementum, alveolar bone, and a functional ligament [36].

Regardless of the grafting material, a clinician can reasonably expect some regeneration of lost alveolar process. Grafting procedures in general have resulted in approximately 50 - 65% of bone fill in periodontal osseous defects [3]. Osseous grafts are not panacea for success and are not substitutes for other forms treatment since each proven therapeutic modality has its proper place in Periodontics, but on the whole, they are quite efficacious.

Different grafting materials are available for regenerative therapy aimed at restoring the alveolar bone but each one has its limitations. To offset the disadvantages of other grafts like autografts etc. two materials have gained significant attention.

Allografts particularly Decalcified Freeze-Dried Bone (DFDBA) has been used extensively because of its osteoinductive mode and because of its property to retain inductive capacity comparative to autografts along with circumventing some of limitations of autogenous bone [22].

In a bewildering array of alloplastic bone substitutes $CaPo_4$ ceramics has become hot target for researchers because of close

chemical and crystal resemblance of these materials to bone mineral. Hydroxyapatite [Ca_{10} (Po_4)$_6$(OH)$_2$] is a tribasic $CaPo_4$ having a ratio of 1.67, which is identical to that of bone [33]. This material is safe and very well tolerated by host tissues. No systemic response and very little local inflammation accompany its implantation [7].

These two materials with different biologic profiles have been tested in separate trials but the literature has been deficient in comparative studies of these two as far as human periodontal osseous defects are concerned.

The lack of the control sites, standardized evaluation techniques and histologic data has contributed to the inconsistency of the result with respect to "defect fill" [12]. Also, since we get some periodontal regeneration even without use of bone grafts [12,24] as has been done earlier, it is in interest of the clinician to assess what additional advantage is being offered by osseous grafts in terms of predictability and amount of bone gain, as compared with control. There is a need to highlight how exactly serves better purpose compared to conventional treatment, which also result in some periodontal regeneration.

In this clinical study, therefore, an attempt was made to valuate/assess/compare the periodontal osseous defects predominantly horizontal bone defects in human lower anterior teeth with resulting from the use of two types of bone grafts i.e. Osteogen (RA Resorb) and Decalcified freeze dried bone allografts (DFDBA), in contrast to conventional treatment.

Materials and Methods

Selection of subjects

Seventeen patients were selected from those attending Outdoor Patient Department of Government Dental College and Hospital for treatment of chronic inflammatory periodontal disease. The patients who were advised to undergo extraction by the oral diagnosis department were taken up for the study. The patients were pooled and out of that lot, cases were selected.

Criteria for inclusion of subjects

1. For admission to study, each patient was required to have at least three osseous defects, as verified by the radiographic analysis, exclusively in relation to lower anterior teeth.
2. No history of any systemic disease, determined by detailed medical history and screening which might influence the periodontal condition or contraindicate periodontal surgery.

Other exclusion criteria were allergy, pregnancy, and presence of any gross dental pathology.

1. Advanced bone loss with adult type of periodontitis in which amount of destruction of bone commensurate with extent of deposits.
2. Clinical probing depth of 5mm or greater.
3. Absence of pathologic migration.
4. No gross malalignment.
5. Mobile teeth (Grade I, II only)
6. Age group: Male or Female 35 years or above.
7. Vital and asymptomatic teeth.
8. Patients demonstrating acceptable oral hygiene prior to surgical therapy.

Other exclusion criteria was:

1. Endodontic involvement of study teeth.
2. Mobility of study teeth greater than grade II.
3. Taking drugs known interfere with wound healing (e.g. Corticosteroids, anti-cancer immune modulators etc.) or who have received such drugs within 4 weeks treatment in study.
4. Smoking and other use of tobacco products.
5. Unacceptable oral hygiene habits.

Subjects recruited for the study were thoroughly briefed about the nature and duration of the study schedule and informed consent was taken. In general, only those patients who had demonstrated positive attitude towards therapy and a desire to commit themselves to long term and complete treatment were selected for the study. Out of 17 patients, three patients could not comply with rigid study protocol and were eventually dropped from the study.

Experimental parameters

Prior to surgery, clinical documentation was done which included:

1. Recording of indices
2. Soft tissue parameters.

Standardized clinical measurements were made using fixed reference points. In this study, cemento-enamel junction was used as fixed reference point [28]. Line angles were used to aid in alignment. All the measurements taken during initial and during surgery were rounded off to nearest millimeter.

Pre-operative, intraoral periapical radiographs, of all test sites were then taken.

Criteria for selection of sites

Only lower anterior teeth were selected as "TEST" sites which were referred for extraction (being labelled as "discarded" cases). The sites did not exhibit any clinical evidence of trauma from occlusion and gross malalignment. The osseous defects which were selected had a crater like morphology i.e. vertical component of bone loss in a horizontal defect, which could retain a graft material.

For determination of gingival inflammation

A non-invasive index i.e. Modified gingival Index (Loe and Silness 1963) [17] was used to evaluate the status of gingiva after completion of phase I therapy, one week, three months Post-operatively and after 9 months.

Criteria for determination of mobility

Miller's mobility index [24] was used for determination of the Mobility of study teeth.

Criteria for determination of probing depth

Probing depth was measured using a graduated William's Periodontal Probe (Hu Friedy). Probing was performed with force equivalent to weight of the handle transferred to tip of the interproximal area of the selected site with long axis of probe tip parallel to the long axis of the selected tooth. Line angles and proximal contacts were used to aid in alignment. The probing depth was rounded off to nearest millimeter.

Criteria for determination of clinical crown length

Clinical crown length was determined by measuring distance from incisal edge to the gingival margin at the midpoint of mesiodistal dimension on the buccal aspect of the selected tooth.

Criteria for determination of clinical probing attachment (CPAG)

Clinical probing attachment gain was determined with the help of probing depth and gingival shrinkage [3,26].

Gingival shrinkage at 3 months and 9 months was determined by subtracting the baseline clinical crown length value from the value at 3 months and 9 months post-operatively, respectively.

Gain in probing depths at 3 and 9 months was determined by subtracting the value at 3 and 9 months from the base line values respectively.

Clinical probing attachment gain was obtained by subtracting the gingival shrinkage from the gain in probing depth (PD): CPAG= GPD-GS.

Materials used: Bone substitutes

Osteogen (HA Resorb)

The hydroxyapatite implant material used in this study was commercially available, highly non porous, non-ceramic, resorbable hydroxyapatite, Osteogen (HA Resorb). The particle size of Osteogen particles was between 300 - 400 microns. Morphologically the bone granules are nearly perfectly formed clusters of relatively hexagonal shaped crystals bound to a single nucleus, forming 360 degrees lattice mechanism for host bone migration. It is a hemophilic and hydrophilic material readily absorbing blood or saline [7].

Decalcified freeze dried bone allografts (DFDBA)

DFDBA is also commercially available and in present study DEMBONE (Demineralized cortical bone powder) was used. The particle size was from 250 - 500 microns.

Pre-surgical management

The patients were provided with a detailed description of the procedure and informed consent was taken. After subjecting the patients to a full diagnostic work up, pre-surgical preparation included oral hygiene instructions, scaling and root planing under local anesthesia 2% lidocaine and plaque control. A re- evaluation of oral hygiene and tissue response was conducted after 4 weeks of post scaling and root planing. The duration of this preparatory phase was varied depending upon the response of the patient to the plaque control program and the rate of resolution of inflammation. Surgical therapy was initiated when the patients demonstrated acceptable proficiency in plaque control procedures. All patients maintained an excellent standard of oral hygiene with consistently low levels of plaque during last few assessments preceding surgery.

Surgical procedure: The standard surgical procedure consisted of internal beveled or sulcular incisions, full thickness flap reflection aimed at preserving as much interproximal tissue as possible, followed by thorough defect debridement and root planing. The defects were cleared of granulation tissue and the exposed root surfaces were thoroughly planed to a smooth hard surface. Following complete debridement of surgical sites, the bone defects were characterized by drafting through a series of measurements taking cemento-enamel junction as fixed reference point. Vertical incisions were given wherever necessary, for obtaining accessibility to the base of defect and in envelope flap care was taken to ensure continuity of angle of flap.

Grafting procedure

The entire surgical procedure was standardized as above for study sites in each patient. Selection of sites as experimental or control was made at the time of surgical procedure after all defect and root preparation had been completed. A Card draw was used as a random code to determine therapeutic modality that would be used in each defect site. One Osseous defect was implanted with Osteogen (HA Resorb), other with DFDBA. The third site i.e. control was left ungrafted, although conventional osseous debridement was carried out.

Placement and dispensing of grafts

The bone graft particles were tamped to place to achieve proper shaping and fill to the highest level of surrounding alveolar walls. Proper condensation was done such that entrapment of air, voids within the implant was avoided. Overfilling of the defect was done.

After surgery, flaps were then approximated, with a concerted effort to achieve complete closure. The mucoperiosteal flaps were positioned at their original level and approximated by primary closure and sutured to place. Non-eugenol periodontal dressing (Coe-Pack) was placed over surgical area for 1 week.

Additionally, antibiotics (Tetracycline 250 mg 6 hourly for 10 days) and analgesics were prescribed. Suture removal was done after 1 week.

Post-surgical protocol

All patients were placed on strict and rigid maintenance schedule following surgery. At every recall appointment personal oral hygiene was re-in forced and practiced. Following the surgical procedure patients were seen weekly for 2 weeks and then every month for nine months. Non-invasive, Modified Gingival index was recorded 1 week post-operatively. At the recall visit (every month) the plaque index was taken to assess the patient's oral hygiene maintenance by utilizing Turesky -Gilmore modification of Quigley Hein's Plaque Index [38]. At 3 months post-surgically, probing depth, clinical crown length, mobility index scores and modified gingival index scores were recorded for evaluation of tissue response.

Methodology

The data obtained from the present study was suitably tabulated in appropriate tables. Student 't' test and paired 't' test were applied to achieve the level of significance, wherever indicated. For studying the changes from baseline to 9 months, the paired 't' test was used. For between the group comparisons student 't' test was used.

For within group comparison: $P<0.05/P<0.01$.

For between group comparison: $P < 0.05/P < 0.01$.

Results

Soft tissue parameters

- Probing pocket depth (PPD).
- Clinical probing attachment gain (CPAG)
- Gingival shrinkage (GS).
- Modified gingival index (MGI).
- Three clinical groups

Control group, Osteogen group (HA resorb) and DFDBA group.

All the three treatment groups in the present study recorded statistically significant decreases in pocket depth at a level of $P < 0.01$ when analyzed by paired 't' test. The inference is that there was a statistically significant decrease in probing pocket depth in all three treatment groups. Between the groups, a comparison of mean of change in pocket depths revealed no statistical significance. Although there was a marginally greater de¬crease in pocket depth in experimental group as compared to con¬trol, this difference was not statistically significant.

In the present study attachment level changes were statistically significant in all three treatment groups at a level of $P < 0.01$ when analyzed by paired t test, although between group comparisons showed the test groups to have statistically significant advantage over the control group. However, the difference between the DFDBA (3.85) and Osteogen group (3.5 mm) mm was not statistically significant.

Within the group there was a statistically significant gingival shrinkage in Osteogen and control group while there was marginal gingival shrinkage in DFDBA group, but this change was not statisti¬cally significant. Between the groups a comparison of mean change of the gingival shrinkage did not reveal any significance as deter¬mined by t test. The inference was that although there was a change in gingival shrinkage in Osteogen and control group this change did not differ from DFDBA group

Within the group there was a statistically significant decrease in the mobility for the three treatment groups that was statistically significant. Between the groups a comparison of mean change in mobility did not reveal any statistical significance. Inference is that there was decrease in mobility in various treatment groups, but this change did not differ significantly from group to another.

Within the group, there was no statistically significant change in the scores of Modified Gingival index, in all three treatment groups. Inference is that there was no statistically significant change from base line to 9 months. In between the groups a comparison of mean change in Modified gingival index revealed no statistical significance. The inference is that there was no statistically significant change in control group as compared to experimental groups.

Discussion

Conventional treatment modalities also show some regeneration even without adjunctive use of grafts [12,22,23]. Clinical data concerning the effectiveness of osseous grafting materials for repairing the periodontium have been subject to criticism because many of clinical investigations failed to compare a bone graft to a control, without a graft. The objection had been raised that a repair would occur without graft. Considering the above, the present study sought to comparatively assess the efficacy of Osteogen HA Resorb and DFDBA in terms of clinical management of periodontal osseous defects. The purpose was to evaluate what additional edge the osseous grafts have over the conventional treatment modality.

The study thereby consisted of three treatment groups namely Osteogen (HA Resorb), DFDBA and control. A total of 14 patients with 42 defects were recruited in this study with random assignment code allotted to each treatment group and the selection criteria of inclusion and exclusion of patients was based on selection criteria underlined by Lynch [19] for the regenerative studies.

In most studies reported, teeth are selected at random with no site specificity, but emphasis is laid on wallular and volumetric configuration [43]. The present study was designed to be restricted to lower anterior teeth since no previous study has been reported to be done in a localized area using DFDBA and Osteogen (HA resorb), with predominantly horizontal defects.

The study was confined exclusively to the lower anterior teeth, with almost identical associated osseous defects, (Predominantly horizontal with vertical component) which were referred for extraction. In view of the fact that dramatic bone fill has been obtained using various osseous grafts, especially autogenous grafts and there has been a supracrestal increase in bone using them, the discarded teeth were recruited for study. Thus, if in hopeless teeth, some amount of bone fill is obtained, thinking in wider perspective it fulfills the requirements of literature in general which suggests the use of osseous grafts for periodontal regeneration as well as in implantology. Also, since the anterior teeth were chosen for study, it facilitated easier and more accurate recording of various parameters.

An attempt was made to select the three identical defects in lower anterior teeth. Although adjacent human periodontal defects do occur, they are by no means symmetric keeping in view the heterogenic bacterial populations and the different accessory etiologies. Despite these deficiencies, the use of clinically similar defects to compare grafted and non-grafted sites in humans are of some benefit as they indicate trends and when combined with other clinical data, are reflective of general state of affairs in biologic systems.

A noninvasive index, modified gingival index was used to monitor the gingival inflammation. A one-week post- operative assessment demonstrated a marginal increase in gingival inflammation in all the treatment groups. It is possible to attribute this, because of marginal magnitudes, to pure surgical inflammation. The 9 months post-operative result showed a consistent total reduction in inflammation in all three treatment groups to the baseline values.

Plaque index was recorded by Turesky Gilmore modification of Quigley Hein index [38] from pre-operative levels to 9 months at one month interval. At every visit the mean score was less than 1 demonstrating a satisfactory level of hygiene maintenance. Patients were subjected to professional oral prophylaxis at every recall visit i.e. one month interval.

Soft tissue assessments in the present study included measurements of the clinical crown length, probing pocket depth and probing attachment gain. All the measurements were repeated at 3 months to evaluate the tissue response. Repeated measurements were taken to reduce the error and all the results were cross-checked [28]. As evidenced by the clinical crown length measurement there was a statistically significant gingival shrinkage in Osteogen and control group with only a marginal shrinkage in DFDBA group, although a between group comparison also failed to reveal any statistical significance.

Probing pocket depth measurement in the present clinical study was done at 3 months initially to assess the response of tissues, although it has been reported that early pocket depth reduction occurs irrespective of the time required for maturation of graft [36].

All the three treatment groups in the present study recorded statistically significant decreases in pocket depth, but in between group comparison showed that although there was a marginally greater decrease in pocket depth in case of Osteogen and DFDBA group than the control, this difference was not statistically significant. However, when multivariate statistical analysis was done, this difference was significant. The gain in clinical attachment levels seen in the present study reflects these improvements. Greater reduction in probing pocket depth in case of Osteogen [26] and DFDBA group than the control has been reported in a variety of studies and these findings are enunciated in present study as well.

In the present study the attachment level changes were statistically significant in all the three treatment groups, although a between group comparison showed the test group to have significant advantage over control groups. However, the difference among the DFDBA and Osteogen group was not statistically significant. Other studies have also reported similar changes with the adjunctive use of bone grafts. The mean 3.85 mm gain of clinical attachment level in DFDBA group is comparable to 2.91 mm as reported by studies [3].

The fact that the use of osseous grafts results in regeneration of bone mass that promotes tissue attachment is undisputed but whether such a healing occurs through long junctional epithelium proliferation or true attachment through cementogenesis, is a matter of intense speculation amongst histological studies [37]. Whatever be the histological phenomenon, through which this improvement in attachment level is mediated, one cannot ignore the fact that these changes will minimize the size of the environments which harbor these periodontal pathogens etiological to periodontal disease.

Soft tissue changes the whole were very satisfactory although neither test material surpassed the other, therefore be, concluded materials significant restoration of the periodontium that has been lost to disease, thus fulfilling the objectives of their use.

The biocompatibility of the bone substitutes has very well, been demonstrated as indicated by various soft tissue assessments and considering the fact that there were no complications. There were no untoward clinical problems or soft tissue reactions related to the use of bone implant materials. Some particles were exfoliated and lost immediately post surgically, but this didn't appear to affect the results. No clinical evidence of any granulomatous or some foreign response was seen in any patient [2].

Taking into consideration that all the requirements were not endorsed to the bone grafts in the present study, the fact cannot

be ignored that both materials have performed well in the present study. So, if the grafts work to desired expectations in an uncongenial milieu they can be stated to have tremendous potential which needs to be tapped thereby giving an additional edge to the patient who is having periodontal disease.

However, there are some limitations of the present study. It was not feasible to locate 'three mirror' image defects. The experimental defects are likely to vary slightly in dimension but care was taken to be as exacting in selection as possible. William's periodontal probe was used in this study for taking various measurements which do not have 4- and 6-mm markings which thereby can be a source of error [28]. Also, no histological evaluation was carried out to establish the exact nature of healing of osseous defects and interface between the graft materials and the bone or tooth surface. Although the bone implants are indicated to work to their best potential in three walled defects, defects with predominantly horizontal type with some vertical component were selected. This was primarily due to fact that study was undertaken in lower anterior teeth where thickness of alveolar process is lesser. Also since the defects were primarily horizontal so the placement and retention of grafts was of little concern.

Conclusion

1. All the groups showed reduction in gingival inflammation after 1 week post surgically and reaching to almost baseline values at 9 months post surgically, with none of groups outperforming the other.
2. There was significant ($P < 0.05$) gingival shrinkage in Osteogen and control group in contrast to DFDBA group where only marginal gingival shrinkage was seen, which when compared did not yield a statistical significance.
3. All groups documented a statistically significant reduction ($P < 0.01$) in pocket depth, with no group outperforming the other. However, on multivariate statistical analysis, the experimental groups demonstrated significant greater reduction in pocket depth as compared with controls.
4. All the groups demonstrated a statistically significant increase in CPAG ($P < 0.01$) with test group i.e. DFDBA ($P < 0.01$) and Osteogen ($P < 0.05$) outperforming the control.
5. All the treatment groups showed significant reduction in mobility index scores although no group could surpass the other.

Decalcified freeze dried bone allografts used in present study proved to be marginally better than Osteogen (HA resorb). Both the implants however offered a significant alternatives to augment conventional open flap debridement.

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Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Conflicts of Interest

The author declare no conflict of interest.

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