Bone Regeneration in Osseous Defects Using Hydroxyapatite Graft and the Extent of Ossification in Osseous Defects Treated Without Grafts: A Comparative Evaluation

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Abstract

Objectives Objective of this study is to evaluate the new bone formation in bony defects following insertion of hydroxyapatite graft and to compare the efficacy and regenerative potential of this bone graft material.

Method The patients having osseous defects after surgery were selected. Preoperatively a brief history, examination, relevant blood investigation and radiographs were taken. Post operative observation period of 6 months was planned. Radiographic and bone scintigraphic (isotope study of bone activity) evaluation of bone specimens was completed in defined time.

Results Radiographic evaluation indicated increased calcification surrounding the material, indicative of acceptance of the graft to the bone. Bone scintigraphic evaluation indicated area of increased bone metabolism and is evidenced as area of increased radiotracer uptake, namely 'hot spots' (active bone formation).

Conclusion It can be concluded that the hydroxyapatite graft met the clinical requirement of a bone substitute material which is biocompatible and non-allergic. The use of this material is advantageous over other bone grafts because of simplicity of application, cost effectiveness and easy availability. Due to its microstructure, complete resorption and neo bone formation took place during the course of this study.

Keywords Hydroxyapatite · Bone regeneration · Osseous defects

Introduction

Local defects in bone arising as a result of trauma or surgery are frequently restored by bone graft [1, 2] substitutes, preferably by autografts and allografts.

Synthetic hydroxyapatite has been the most frequently used allograft material due to its chemical composition, similar to human bone. It is non toxic, has a high chemical stability, causes less inflammation and antigenic reaction. Another important property is that its microstructure can be controlled to promote the formation of pores that can allow the migration of blood vessels and bone tissues into the material [3, 7].

In the present study, hydroxyapatite Periobone-G was used as graft material. It is made through ceramic processing techniques and supplied in the form of porous granules.

Material and Methods

Study was carried out on 38 patients (20 males, 18 females) with age ranging from 20 to 45 years. Medically compromised patients, cases of acute infection, pregnant and lactating females were excluded from the study. Cases of periapical cyst, peri apical pathology and extraction were selected and healing with and without grafting of osseous defect was evaluated. Size of osseous defect between 5 and 15 mm were included in the study (Mean size = 11 mm). Patients having bicortical perforation were excluded. Patients were randomly divided equally (i.e. 19 patients

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each) in group 'A' (natural healing) with a mean age of 29 years and group 'B' (healing with graft) with mean age of 31 years. Follow up to 24 weeks was done. The surgical procedure was performed to remove pathologies or tooth. Complete debridement of the defect and curettage were done and sharp margins of the defect were rounded. In control group (Group A), mean size of the defect was 10 mm and no graft placement was done (Fig. 1), complete debridement of the defect and curettage were done. Closure of flap and post-operative medication prescribed were antibiotics (amoxicillin 500 mg, every 8 h), analgesic (ibuprofen 400 mg, every 8 h) for 5 days and 0.2% chlorhexidine gluconate rinses (every 12 h, 1 day after surgery).

In test group 'B', mean size of defect was 11 mm and all defects were packed with mixture of hydroxyapatite granules (Periobone-G, particle size 0.15–0.35) and patients intravenous blood (Fig. 2). Within minutes it attains a semisolid consistency then it is packed into the defect to the level of surrounding bony wall. Care was taken not to overfill the defect. The flap was then approximated and primary closure was done using 3–0 mersilk suture. Gauze dressing was placed over the area. Post-operative medications were given in same manner.

Periodic recall up to 24 weeks was done to assess tenderness, swelling, infection and graft rejection. Visual analogue scale (VAS), radiographs and scintigraphy techniques were used as assessment tools for this purpose.

Results

No significant difference in pain was assessed between two groups at first week and second week using standard VAS for pain. However, on fourth week and 12th week, group B showed significantly lower pain score as compared to Group A. Swelling was higher in 50% cases of group 'B' at second week. No infection was seen till second week in either of the two groups. One patient in group A developed

Fig. 1 Osseous defect without graft

Fig. 2 Defect filled with HA graft

Fig. 3 IOPA after 3 months showing no evidence of bone formation

Fig. 4 IOPA after 3 months showing radiopacity indicating bone formation

infection who was operated later on. Statistically, there was no significant difference between the two groups. Graft was not rejected in any of the 19 cases under study as one patient of Group B did not turn up for follow-up after second week.

Radiographically in group A, up to second week follow up no evidence of calcification was seen. On 12th week follow up, in 18 patients (94.76%) evidence of beginning of calcification was observed (Fig. 3). While in group B, up to second week follow up, no evidence of calcification could be seen. On fourth week follow up, evidence of beginning of calcification was seen in 18 (94.76%) out of 19 cases. On 12th week follow up, in 19 patients marked evidences of calcification was seen (Fig. 4).

Comparison of radiographic assessment findings between two groups revealed statistically no significant difference till second week follow up ($P > 0.05$, NS). On 12th week follow up, group B had a significantly better response as compared to group A ($P < 0.001$). On the basis of scintigraphy, the quality of results achieved (suggestive of osteoblastic activity) in group A (Fig. 5) was lower as compared to group B (Fig. 6).

Discussion

Bone substitute materials are employed primarily to serve as a filler and scaffold to facilitate bone formation and wound healing [4]. This includes the use of different

Fig. 5 Scintigraphy showing normal osteoblastic activity at natural healing site and increased osteoblastic activity in the area of grafting with HA

Fig. 6 Scintigraphy showing increased osteoblastic activity in the area of grafting with HA

variety of synthetic bone graft substitute and barrier membranes [5, 6].

In the present study, the SPECT images scintigraphically shows areas of increased bone metabolism and appear as areas of increased radiotracer uptake namely “hot spot” and are usually interpreted as evidence of bone survival and patent micro vascular neoformations, whereas decreased uptake is associated with metabolically inactive bone, lack of osteogenesis, or hypo-vascularity of bone.

The bone is deposited directly onto the surface of hydroxyapatite without intervening fibrous tissue. Hydroxyapatite is not osteoinductive but is osteoconductive that is when placed next to viable bone, an advancing front of new bone grows into the porous matrix [7]. The immune reactions can be completely ignored, morphological changes and a decrease in a volume do not occur.

Within the limits of the experimental and clinical studies, these results indicate that the tested hydroxyapatite [8] met the requirement and can be used successfully as an adjunct in management of various osseous defects and appears to be beneficial to the patient.

Conclusion

Bone substitutes are in great demand in the treatment of various disorders like periodontal diseases, dental periapical abscess, bone tumors, trauma and other bone defects. The use of autogenous bone has remained the gold standard in restoring bone defects, but it is not always possible to obtain enough bone or the amount of bone needed may exceed than the available [9].

For these reasons, biomaterials have been investigated as an alternative to autogenous bone grafts [10]. Synthetic hydroxyapatite has been most the frequently used material because its chemical composition is similar to human bone [11]. From this comparative controlled clinical study, it was concluded that:

- 1) There was a good clinical and radiographic response when hydroxyapatite was used.
- 2) Excellent post surgical healing response to hydroxyapatite treatment with no adverse complication.

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