Study of Natural Hydroxyapatite in Regeneration of Bone in Periapical Defects: A Clinical and Radiographic Study

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ABSTRACT

In this study cases in the age group of 18-40 years were selected from the Out Patient Department of D.A.V. (C) Dental College & Hospital, Yamuna Nagar. Traditionally autografts have been used as the first choice, as they do not provoke immune reaction that may cause rejection. Potential problem associated with alternative bony substitutes such as; donor site complication and transmission of various infectious agents are eliminated. The present study was an attempt to evaluate clinically and radiographically the efficacy of regenerative potential of natural hydroxyapatite.

Key words : Natural Hydroxyapatite, Periapical Surgery, Bone Regeneration

INTRODUCTION

Teeth with pulpoperiapical pathoses may be treated conservatively or surgically. Periradicular surgery is less often the first choice of treatment in non-healing periradicular pathoses. However, it is undertaken after unsuccessful retreatment or when the conservative treatment is not possible or patient wants early treatment for lack of time. Also, the teeth with large periapical defects are difficult to treat even with specialised conservative techniques and materials.The regeneration of bone following periapical surgery has an important bearing on success following treatment.

One of the reason of inadequate bone healing is ingrowth of connective tissue into the bone space, preventing osteogenesis.

To prevent ingrowth of connective tissue and early regeneration of bone following periapical surgery, bone grafts can be placed into the bony cavity. Different types of bone grafts are available for dental surgical procedures. These include, autografts, allografts, xenografts and alloplastic grafts. Although the most biologically acceptable bone graft is fresh, viable autologous bone, yet the inherent problems associated with it, are the need for additional surgical procedure, the post surgical pain associated with a second surgical site and variable resorption. In light of these complications, numerous investigations are being done in search for a suitable alternative to autologous bone graft

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that meets the requirement of an ideal bone graft.

Recently, ceramic materials have gained a considerable amount of popularity as bone grafts. Among them, calcium hydroxyapatite (HA) and tricalcium phosphate (TCP) are commonly used1. Hydroxyapatite has been used as bone substitute for alveolar ridge augmentation2,3,4, orthognathic surgery5, periodontal intrabony defects6, metaphyseal defect7,8 chin augmentation9, innominate osteotomy etc. with encouraging results.

Ceramic and natural hydroxyapatite may be used in regeneration of bone with good results as reported by Beck-Coon Robert J et al (1991)10 and Kandaswamy D et al (2000)11 respectively. Natural hydroxyapatite meets most of the essential requirements of bone graft to regenerate bone in osseous defects of endodontic origin[12].

The natural hydroxyapatite derived from animal bone (xenografts) has been introduced lately. It has greater similarity to natural bone, is biocompatible, biodegradable and helps in bone formation by osteoconduction. The major advantages of hydroxyapatite implants are that it offers the potential of an unlimited supply of bone substance, absence of donor site morbidity and decreased operative time. The risk of transmission of the disease-bovine spongiform encephalopathy (BSE) from bovine bone grafts is negligible and can be attributed to the stringent protocols followed in sourcing and processing of the raw bovine bone as reported by Sogal A and Tofe AJ (1999)[13].

The present study is an attempt to evaluate clinically and radiographically the efficacy of regenerative potential of natural hydroxyapatite.

MATERIALS AND METHOD

Fifteen cases in the age group of 18-40 years were selected from the Out Patient Department of D.A.V. (C) Dental College & Hospital, Yamuna Nagar. Cases with bilateral involvement of maxillary incisors with distinctly separate radiographic periapical lesions of approximately 1 cm diameter were selected. There was no periodontal involvement in any of the cases selected. NATGRAFT was used which is a natural hydroxyapatite, specially processed bovine bone, in granular form. This product is manufactured by Graftech, Chennai, India with following specifications:-

The granules are white in colour measuring 100 to 250 microns in size.

Available in presterilized vials (Gamma Irradiated at 2.5 mega rads). Biocompatible and bioresorbable.

Cleared by American Society for Testing Materials F-1185-88; confirms to ASTM specifications.

All radiographs for the study were taken under standardized conditions. Long cone paralleling technique was followed using Hawe X-Ray film holder (Hawe Neos Dental, Switzerland) with a fixed focal object distance of 20 cm. Kodak E-speed periapical films (Eastman Kodak Company, New York) were used. The radiographs were processed using standardized procedures.

The rubber dam was applied on the involved teeth. The root canals were prepared, enlarged and shaped according to the principles of root canal preparation as given by Grossman14. The obturation was done with Gutta Percha points.The access opening was then sealed with reinforced Zinc-Oxide Eugenol.A prophylactic antibiotic therapy was started one hour prior to surgery i.e. Amoxycillin 2 gm stat and was continued 500 mg. 8 hourly for 5 days. Pre-anaesthetic medication - Diazepam 10mg was given orally half an hour before the surgical procedure.

Routine blood and urine examination were carried out. A full thickness flap was raised using mucoperiosteal elevator exposing the periapical area.

After locating the periapical lesion, granulation tissue was curetted. This was followed by apicoectomy. The Gutta Percha protruding from the apical portion of the root canal was cut and cold burnished with a ball

Fig 1: Bilateral Bony Defects

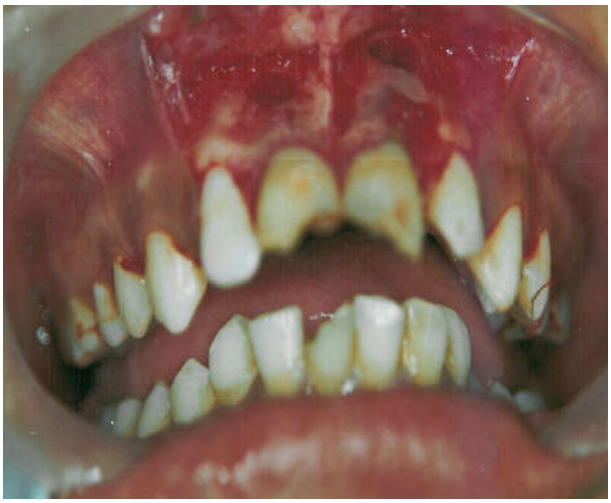
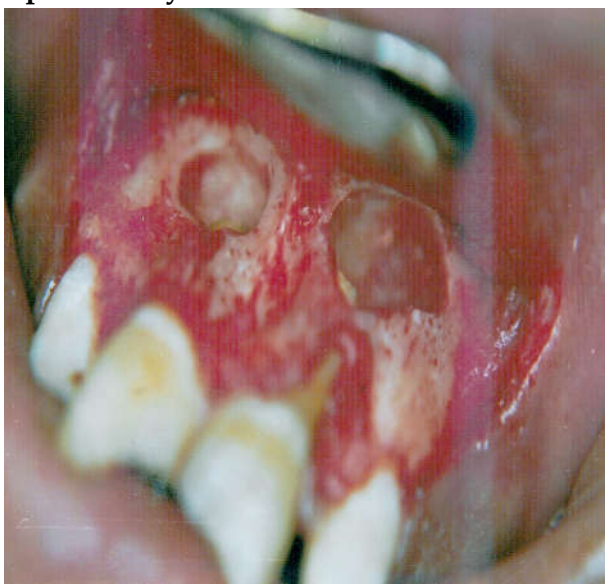


Fig 2: Bony Cavity after Currettage and Apicoectomy



burnisher.

In the experimental group, the NATGRAFT (Graftech, Chennai) granules were placed with amalgam carrier layer by layer and compressed against the surrounding walls of bony cavity with the help of amalgam condenser till the bony defect was filled completely. In the control group, the bleeding was induced in the bony cavity and the blood clot was left.

Fig 3: Placement of NATGRAFT in Bony Cavity

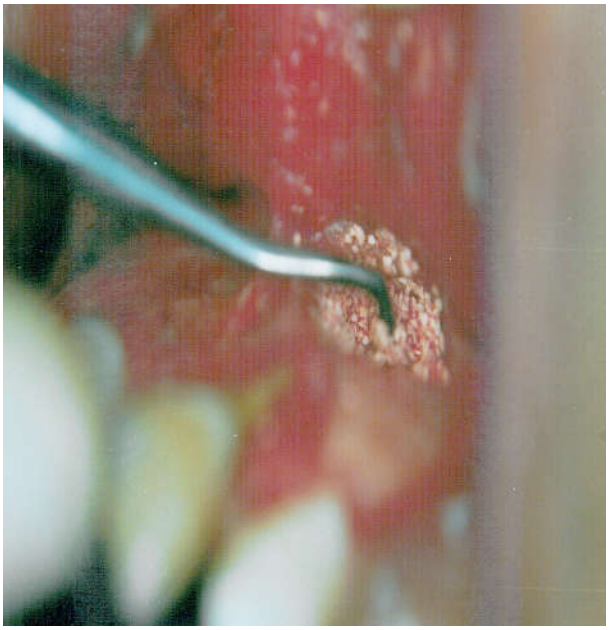
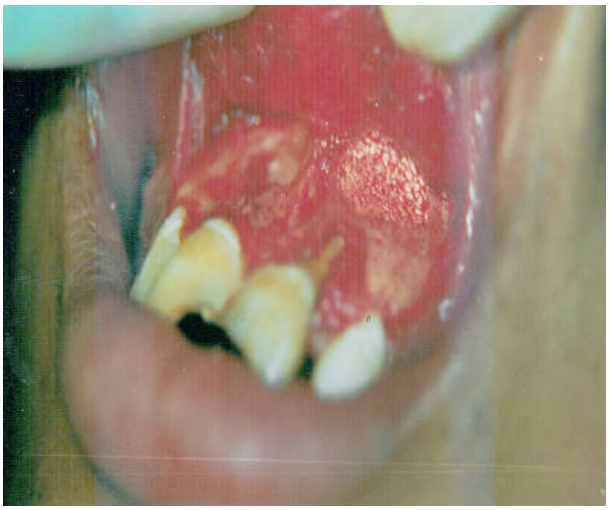


Fig 4: NATGRAFT Granules on Left Side (Experimental) and Blood Clot on Right Side (Control)



The patient was recalled after four weeks, eight weeks, twelve weeks, and twenty four weeks for the clinical and radiographic evaluation to access the condition of the periapical area.

An intraoral periapical radiograph was taken on each follow up visit and accessed regarding;

Decrease/increase in the size of radiolucency

Decrease in the size of graft material

Appearance of trabecular pattern

All radiographs were superimposed with transparent sheet, the outline of the graft material on experimental site and radiolucent area on control site were marked with a marker. These outlines were scanned and loaded into the computer. Using the Radiovisiography (RVG) software, size / area of the outline was calculated.

POSTOPERATIVE EVALUATION

The postoperative evaluation of all the subjects was done clinically and radiographically for a period of twenty four weeks starting from the day of surgery.

The results were recorded and tabulated ;

I. Clinical evaluation.

II. Radiological evaluation (Table 1 to 3)

The results were put to statistical analysis and tabulated .

CLINICAL EVALUATION

All the fifteen patients were comfortable, with no swelling and no pain on percussion at experimental site as well as at control site. No extrusion of the graft material was seen in any of the case at experimental site.

RADIOLOGICAL EVALUATION

Immediate post operative radiograph showed radioopacity of the graft material on experimental site. The control site was seen as a radiolucent area, indicative of bony defect with blood clot only.

After four weeks on experimental site, the mean percentage decrease in the size of the graft material was 16.59% and on the control site, the mean percentage decrease in the size of the radiolucent lesion was 20.07%. The trabecular pattern was visible in 66.66% cases on experimental site but not in any of the case at control site.

After eight weeks on experimental site, the mean percentage decrease in the size of the graft material was 27.14% and on the control site, the mean percentage decrease in the size of the radiolucent lesion was 41.01%. The trabecular pattern was visible in 93.33% cases on experimental site and in 40% cases on control site.

After twelve weeks on experimental site, the mean percentage decrease in the size of the graft material was 34.45% and on the control site, the mean percentage decrease in the size of the radiolucent lesion was 55.80%. The trabecular pattern was visible in each and every case on experimental site and in 80% cases on control site.

After twenty four weeks on experimental site, the mean percentage decrease in the size of the graft material was 44.53% and on the control site, the mean percentage decrease in the size of the radiolucent lesion was 74.60%. The trabecular pattern was visible in all the cases at experimental site as well as at control site.

STATISTICAL ANALYSIS

The two-way ANOVA showed that there was highly significant ($p<0.001$) decrease in the size of the graft material in experimental group as well as in the size of the radiolucent lesion in control group. Chi square test showed that there was significant ($p<0.05$) difference in the appearance of trabecular pattern after four and eight weeks between experimental and control group.

DISCUSSION

The ultimate goal of periapical surgery is the predictable regeneration of periapical tissues, including a complete repair of osseous defects. Inadequate bone healing is caused by ingrowth of the connective tissues into the bone space,

Table 1: Percentage Decrease in Mean Size of the Graft Material (Experimental Group)

After 4 weeks (in percentage)	After 8 weeks (in percentage)	After 12 weeks (in percentage)	After 24 weeks (in percentage)
16.59	27.14	34.45	44.53

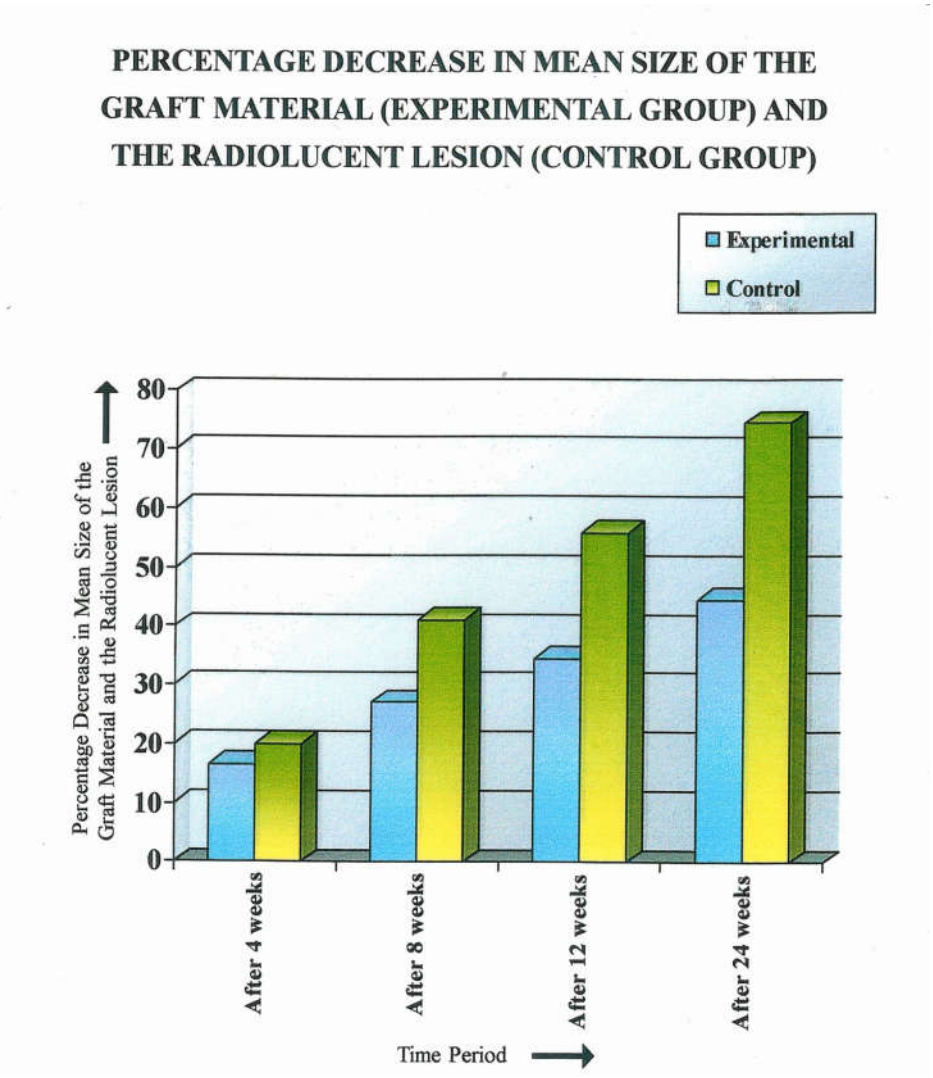
Table 2: Percentage decrease in mean size of the radiolucent lesion (control group)

After 4 weeks (in percentage)	After 8 weeks (in percentage)	After 12 weeks (in percentage)	After 24 weeks (in percentage)
20.07	41.01	55.80	74.60

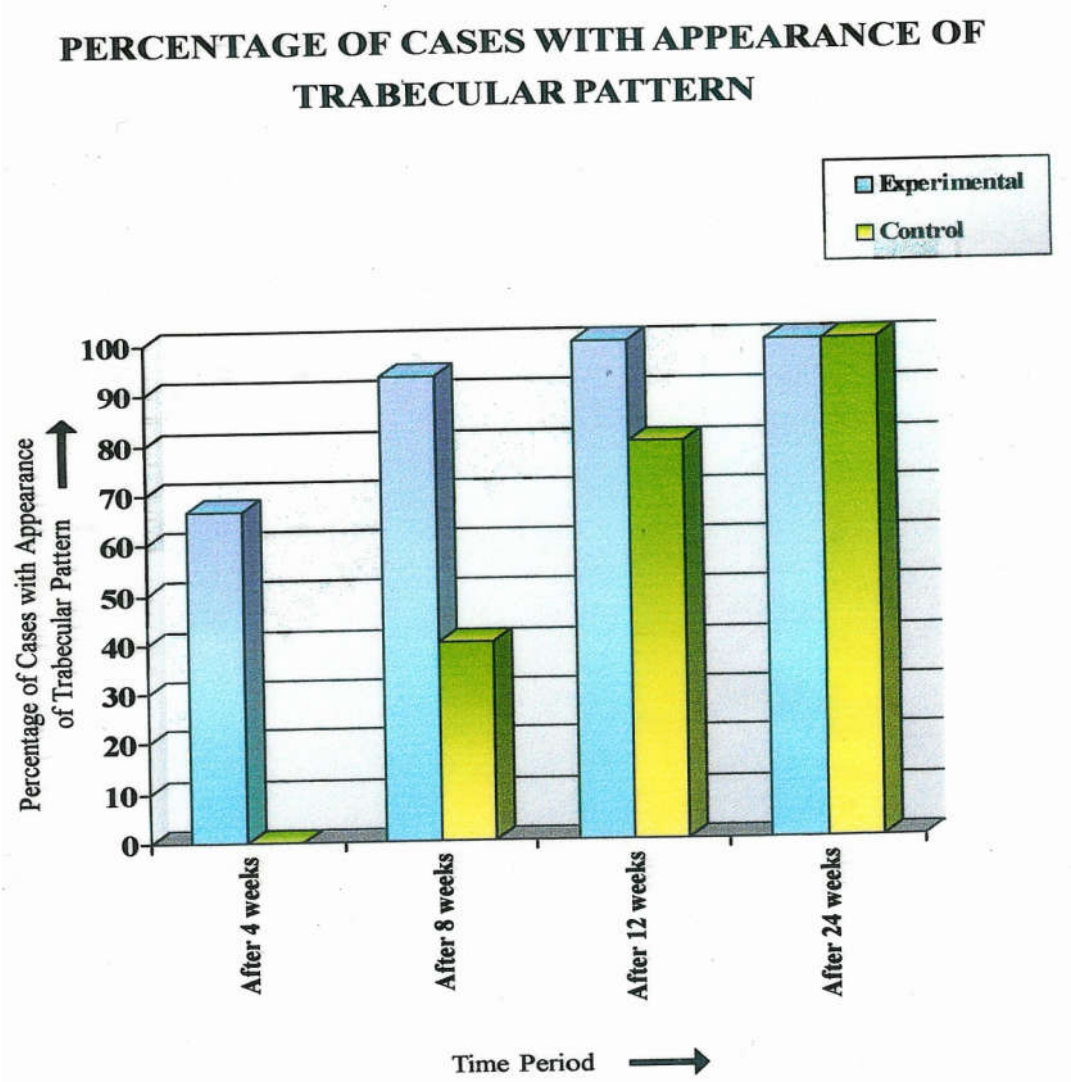
Table 3: percentage of cases with trabecular pattern

Group	Total No. of cases	No. of Cases with Appearance of Trabecular Pattern (in percentage)			
		After 4 weeks	After 8 weeks	After 12 weeks	After 24 weeks
Experimental	15	10 (66.66%)	14 (93.33%)	15 (100%)	15 (100%)
Control	15	0 (0.0%)	6 (40.0%)	12 (80.0%)	15 (100%)

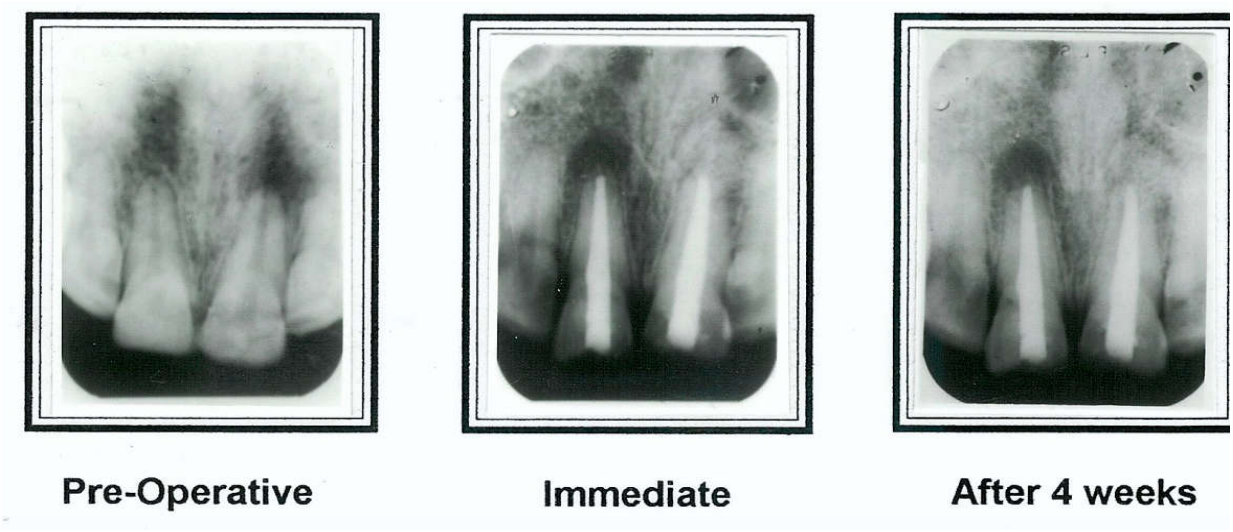
Graph A

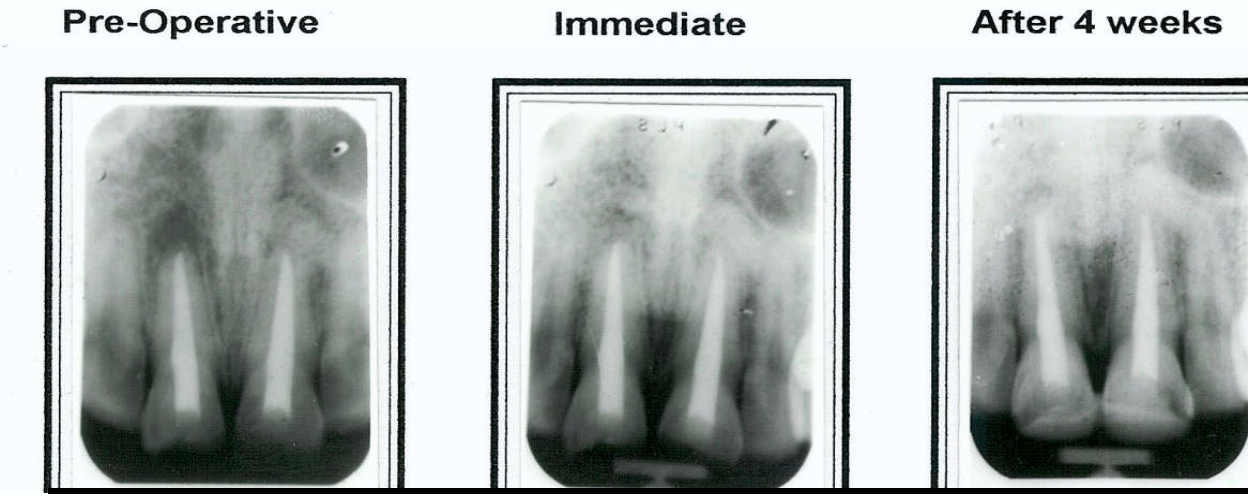


Graph B



Radiographic Evaluation





preventing osteogenesis. Sometimes, if the defect is larger, the bone regeneration process might not extend into the central portion of the gap, leading to the formation of the fibrous tissue.12 Sometimes for the subsequent orthodontic and prosthodontic treatment to be performed, early osseous healing is required. In order to prevent the soft tissue ingrowth, fibrous tissue formation and to accelerate bone regeneration following periapical surgery, grafts may be placed in the periapical defects. It will also help to obliterate dead space in the cases of large bony defects.

Different bone grafts are available for dental surgical procedures.15 Traditionally autografts have been used as the first choice, as they do not provoke immune reaction that may cause rejection. To avoid a separate surgical procedure to harvest a bone graft, alternative biocompatible grafts may be used.

Recently, ceramic materials like hydroxyapatite and tricalcium phosphate have gained considerable popularity as bone grafts1. Hydroxyapatite is a safe, biocompatible, readily available, can be contoured to any shape, has sufficient mechanical strength and permits rapid growth of bone. Bovine derived hydroxyapatite increases the available surface area that can act as an osteoconductive scaffold due to their porosity and have a mineral content comparable to that of human bone, allowing them to integrate with host bone.16 Potential problem associated with alternative bony substitutes such as; donor site complication and transmission of various infectious agents are eliminated.[8]

The present study was an attempt to evaluate clinically and radiographically the efficacy of regenerative potential of natural hydroxyapatite- NATGRAFT in periapical bony defects. Natgraft is specially processed bovine bone, used in granular form.

On clinical evaluation, all the patients were comfortable, with no swelling or pain on percussion on experimental as well as control site. No extrusion of the graft material was seen in any of the case.The results concur with the results of Drobeck HP et al (1984)17, and Kandaswamy D. et al (2000)11 They also reported that hydroxyapatite when used as a bone substitute revealed no evidence of inflammation, infection or abscess. It may be due to the fact that hydroxyapatite is well tolerated by host tissues and does not appear to cause any immunological reaction.

Hydroxyapatite material is osteoconductive i.e. when placed next to viable bone an advancing front of new bone grows into the porous matrix. Hydroxyapatite conducts new bone formation not only around hydroxyapatite but also into the pores in a very short period.

The comparatively delayed appearance of trabecular pattern in the control group might be due to the fact that repair in teeth treated by conventional method proceeds at a slower pace depending upon the response of

individual to treatment as compared to those where some biologically acceptable graft has been used to initiate as well as to accelerate new bone formation. Further in the control group the bone regeneration starts from the periphery and proceeds towards the centre to fill the bony defects after apicoectomy. But in the experimental group, uniform bone formation occur throughout the bony cavity. Similar observations have been made by Mors WA and Kaminiski EJ18 who demonstrated ingrowth of new bone into the pores in manner similar to normal growth. But the graft did not resorb completely and masks the results. Similar findings of no resorption of hydroxyapatite even after one year and three years were also reported by Mahan Kieran T et al (1999)19 respectively. Also, Beck-Coon Robert J et al (1991)10 had reported that the radioopacity of the hydroxyapatite made the evaluation difficult. The results of present study were contarary to the study of Levin Marein P et al (1974)20 who reported that no ceramic (tricalcium phospate) was found after twenty two weeks.

During six month follow up, The earlier appearance of trabecular pattern at the experimental site as compared to control site indicates that hydroxyapatite is an osteoconductive material i.e. when placed next to viable bleeding bone, an advancing front of new bone grows into and around the graft material.5,21 But the Natgraft did not resorbs even after twenty four weeks and there was less decrease in size of the graft material at experimental site as compared to decrease in size of the radiolucent lesion at control site. The radiopacity of the graft material mask the results and made the evaluation difficult.

So hydroxyapatite may be used in periapical bony defects as it gives a good primary closure and encourages wound healing preventing the ingrowth of connective tissue into the bony defect.

However, a long term study with variety of clinical cases and large sample size with histological sampling would be very useful to evaluate the actual extent of osteoconductivity. The fate of hydroxyapatite and its role in bone formation needs to be investigated further in the form of isotope study of bone activity

CONCLUSION

The natural hydroxyapatite - NATGRAFT was found to be biocompatible and had no significant local tissue reaction.

In comparison to the conventional periapical surgery, the placement of NATGRAFT facilitated early appearance of trabecular pattern, indicative of earlier bone regeneration.

The NATGRAFT was found to be cost effective, easily available, easy to manipulate and involves least complication to both clinician and patient.

However, there was comparatively less decrease in size of the graft material as compared to radiolucent lesion on control sites. The graft material did not resorb even after twenty-four weeks and its radiopacity probably interfered with the evaluation.

In the view of these findings, NATGRAFT facilitates osseous healing in periapical bony defects. However, the fate of hydroxyapatite and its role in bone formation need to be investigated further in the form of isotope studies for a longer follow up period.

However, a long term study with varieties of clinical cases and long sample size using this material is essential to conclude on its further efficacy.

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