COMPARISON BETWEEN A CONVENTIONAL TECHNIQUE AND A BONE REGENERATION TECHNIQUE USING HYDROXYAPATITE CRYSTALS IN PERIRADICULAR SURGERY

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Abstract

Background – This study examined the new bone formation in bony defects following insertion of hydroxyapatite graft, to study bone healing and obliteration of osseous defects and to compare the efficacy and regenerative potential of this bone graft material.
Methods – The patient having osseous defects were selected from the outpatient department of oral and maxillofacial surgery. Preoperatively a brief history, examination, relevant blood investigation and radiographs were taken. A total observation period of 6 months was selected. Radiographic and Bone scintigraphic (isotope study of bone activity) evaluation of bone specimens was completed in defined time.
Results – Radiographic evaluation indicate increased calcification surrounding the material, indicative of a firm union of the graft to the bone. Bone scintigraphic evaluation indicates area of increased bone metabolism and is evidenced as area of increased radiotracer uptake, namely 'hot spots' (active bone formation). Complete resorption of the graft had taken place after 12 weeks.
Conclusion - It can be concluded that the evaluated hydroxyapatite graft met the clinical requirement for a bone substitute material and the material 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 took place during the course of this study

Key Words: Bone regeneration, Hydroxyapatite, Osseous defects.

Introduction

Human skeletal system has evolved over millions of years and has a unique capacity to regenerate & repair the damages that occur below the critical size. Management of defects in the bone that are difficult to reunite was a major challenge to human mind over centuries.

Local defects in bone arising as a result of trauma, tumors, and infections are frequently restored by bone grafts substitutes and preferably used are autografts and allografts.[1]

Soft tissues can cover large traumatic bone defects but reconstruction of the bone itself may be difficult. The use of autogenous bone has remained the golden standard in restoring bone defects, but it is not always possible to obtain enough bone as the patient may have undergone previous bone grafting procedures and thus has poor donor sites or the amount of bone needed may exceed that available. In addition, harvesting is always a secondary operation and implies a certain amount of morbidity[2].

To avoid these problems, allograft bone can be stored for later use. Unfortunately this does not solve all the problems, as there is always a risk of being infected by viruses or bacteria, when allograft bone is used. Moreover, the immunogenic responses may impair the results.

Some of the most significant advances in the biomaterials over the last 20 years have been in the field of bone graft substitutes. Bio-resorbable porous bone substitutes especially bio-ceramics may reduce the disadvantages associated with autografts, allografts and other synthetic materials currently used in bone graft procedures. They share numerous advantages over autografts, allografts, which include unlimited supply, non-toxic and non-allergic nature, easy sterilization and storage[1].

The use of ceramics originated from research in early 1970's, has led to the introduction of variety of bio ceramics owning to the close resemblance in physiochemical properties.

Considering the desmographic changes of today's aging population, the requirement for new approaches to replace degenerated bone is also a major socioeconomic need. The treatment of local bone loss of the maxillofacial region due to atrophic process is a significant challenge[3].

In the present study, a newly introduced material hydroxyapatite is used. It is made through ceramic processing techniques, supplied in form of porous granules. The material is tested for phase purity, safe level of trace elements and biocompatibility. It is useful for bone regeneration in cystic cavities, extraction sockets, and for ridge augmentation. The granules show osteoconductivity at bony site. Their surface easily integrates within the newly growing bone and porous structure allows bone in growth into the granules, this result in the faster healing of the defect site.

Material and Methods

This study was under taken on the patients having osseous defect which were selected from the outpatient of Department of Oral & Maxillofacial Surgery, irrespective of the age, sex, and religion. Thirty eight patients (20 females and 18 males) were recruited for treatment. All

patients were informed of the procedure and their consent obtained.

The patients included were based on Presence of osseous defects (either due to removal of cyst, periapical pathology, extraction of an indicated tooth etc.), the age of the patients are between 16 to 40 years, patients without compromised medical history.

Medically compromised patients, pregnant and lactating mothers, recent myocardial infraction, Severe renal disorder, Regional malignancy, Respiratory disorders and Patients not willing to participate in the study were excluded.

The patients were taken in two groups:

Group A - Osseous defects treated without grafts.
Group B – A commercially available, sterilized hydroxylapatite crystals (0.15-0.35 mm) were used to fill osseous defects.

A thorough clinical examination, orthopantomograph, intra oral periapical radiographs, routine hematological examination was carried out prior to surgery.

Surgical Procedure

The surgical procedure was performed under local anesthesia of 2% lignocaine hydrochloride containing adrenaline at a concentration of 1:2,00,000. Incision was given according to the site to be exposed flap was reflected, and defect was exposed. Complete debridement of the defect and curettage were done using bur and curettes, Sharp margins of the defect were rounded using bone filer and wound toilet was performed.

Treatment of the defect was as follows:

In test group hydroxyapatite granules particle size 0.15-0.35 were mixed with patients intravenous blood and were used to fill the defects. 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 with an interrupted technique. Gauze dressing was placed over the area.

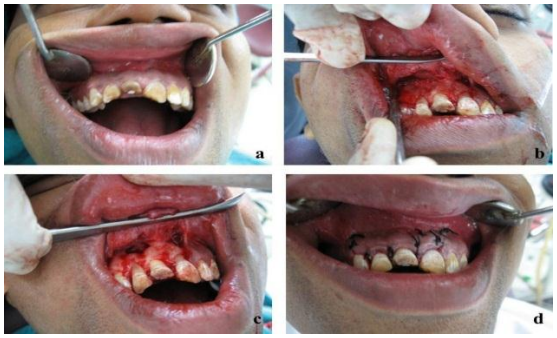

Figure 1: - a) Preoperative; b) exposure of the defect; c) Graft placed into the defect; d) Final Closure

In control group, no graft placement was done into the defect, complete debridement of the defect and curettage were done using bur and curettes, Sharpe margins were rounded using bone filler, only blood was left in the defect.

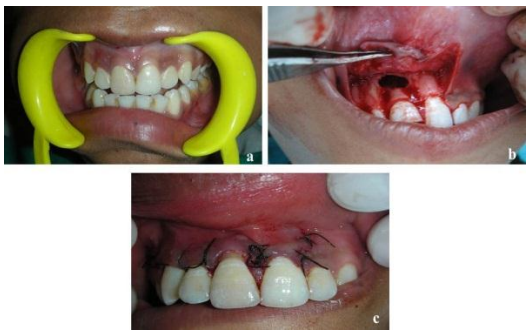

Figure 2: - a) Preoperative; b) exposure of the defect; c) Final closure

Result

The present study was conducted on 38 patients to compare the efficacy and efficiency of graft against the conventional method of correction of osseous defects.

The patients included in the study were divided into two groups:

Group A: Comprised of 19 patients in whom no graft was used.
Group B: Comprised of 19 patients in whom graft was used.

Upto 2nd week follow up no evidence of calcification was seen. On 4th week follow up, 18 patients (94.76%) showed evidence of beginning of calcification. On 12th week follow up, in 8 patients (42.11%) evidence of beginning of calcification was seen while in 10 (52.63%) marked evidence of calcification was seen. On 6th month follow up interval, complete ossification was not seen in any of the patients while in 18 (94.76%) marked evidence of calcification was seen. Upto the end of follow up, there was 1 (5.26%) patient in whom no evidence of calcification could be noted. On the basis of marked evidence of calcification, the success rate was calculated as 94.74%

Upto 2nd week follow up, no evidence of calcification could be seen. On 4th week follow up, evidence of beginning of calcification was seen in 18 (94.76%) out of 19 cases. In one patient, follow up could not be performed after 2nd week. In the remaining 18 patients, marked ossification was seen by 12th week follow up. On 24 weeks' follow up, evidence of complete ossification was seen among all the cases. On the basis of complete ossification, the success rate was recorded as 100%.

Comparison of radiographic assessment findings between two groups revealed statistically no significant difference till 12th week follow up. On 24th week follow up, Group B had a significantly better response as compared to Group A. Although in Group A, a success rate of 94.76% was noted as compared to 100% in Group B, it is pertinent to note here that the quality of results achieved in Group B (marked by "complete ossification") was significantly higher as

compared to Group A (marked by "marked evidence of calcification" only).

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 variety of synthetic bone graft substitute and barrier membranes. Newer techniques and equipment have dramatically improved in the 1990`s. Bone grafts are frequently being used in the field of oral and maxillofacial surgery to repair bone defects and promote new bone formation[5].

Increasing interest in bioactive ceramics, particularly in hydroxyapatite over the past ten years, has resulted in a considerable increase in their clinical application[6]. The bone graft containing hydroxyapatite get more rapidly incorporated into the host bone, because it already incorporates biological apatite. This is one of the rationale for employing it as a bone substitute material.

The present study was undertaken to determine the efficacy of hydroxyapatite when grafted into the osseous defects, with that of the control group. Of the total of 38 patients (20 females and 18 males) with the age ranging from 16 to 40 years with osseous defects were registered for the study, two patients had to be removed from the study for different reasons: one patient (group A) needed further surgery after fourth week of the initial operation because of developing infection. One patient from group B was removed because did not return for review. At the end of the study 36 patients were considered for study and the observation were entered in data sheet which include patients details, parameters of pain, swelling, infection, graft rejection/acceptance, bone scintigraphic evaluation and patient follow up at 1, 2, 4, 12, 24 weeks postoperatively.[5]

As the X-rays are not very much reliable for determining bone graft viability and deposition of mineral contents during the first month because changes in the mineral content can only be detected if the alteration amount to at least 30-40%. The sufficiency of the blood supply and the viability of the graft can be proved early if capillary proliferates are present in a histological examination. However, this requires the invasive procedure of the bone biopsy which might disturb the healing again. Bone scintigraphy is a non-invasive method that utilizes radioactive isotope that plays a valuable role in determining vascular patency of the graft. Tc-99m MDP is the most commonly used tracer. The bone imaging agent circulates through the blood stream until they are either incorporated into the sites of active turn over or excreted in urine.

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.

Results of this clinical trial demonstrate that hydroxyapatite as a bone graft substitute, is beneficial in the treatment of osseous defects.

Hydroxyapatite has several advantages: No donor site is required, Unlimited supply of the material, Easy procedure, No risk of transmission of disease[4].

The bone is deposited directly onto the surface of hydoxyapatite without intervening fibrous tissue. Hydroxyapatite is not an osteoinductive & does not stimulate osteogenesis, but is osteoconductive that is when placed next to viable bone, an advancing front of new bone grows into the porous matrix[4]. The immunoreactions can be completely ignored, morphological changes and a decrease in a volume do not occur if the granules are of adequate size and are packed densely and firmly.[6]

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