Effects of Indigenously Prepared Natural Coral Skeleton on Bone - An Animal Study

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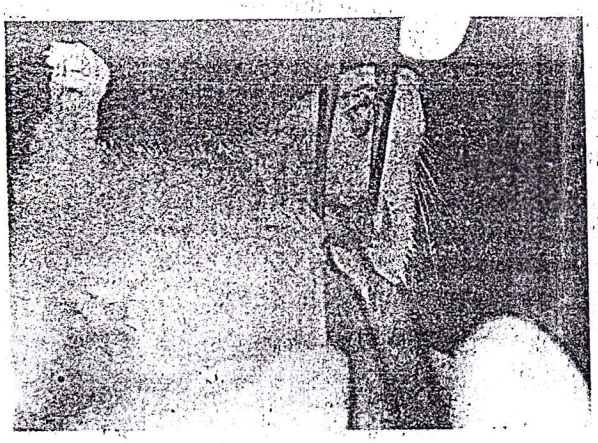
Introduction

Augmentation or onlay grafting is a comouflagic procedure preferred for reconstructing skeletal deficiency. For years surgeons have been searching for an ideal implant material that can be easily sculptured, biocompatable, easily available and preparable to augment or to reconstruct the facial skeleton.

Early works with demineralized bone to recent metals, alloys, polymers and hydroxyapatite have proved success rates with variable degree with their own advantages and disadvantages. These materials demand high preparative technology, specialized instrumentation and high cost.

Coral Augmented on Mandible

Over past 20 years a great deal of interest has evolved among the bioscientists in the application of the natural coral skeleton for bone augmentation procedures. These skeletons are highly porous aggregates of tiny compartments which are interconnected with varying solid, void ration and consists of 99% calcium carbonate, 1% trace materials and various studies have documented their biocompatability and bone formation.



Surgically Exposed Mandible

An animal study was conducted in the departments of oral and maxillofacial surgery and oral pathology of Raja Muthaiah Dental College and Hospital Annamalai University to evaluate the behaviour of Indigenously prepared natural coral skeleton, on wistar rat mandible.

Aim

To evaluate histological changes and biological

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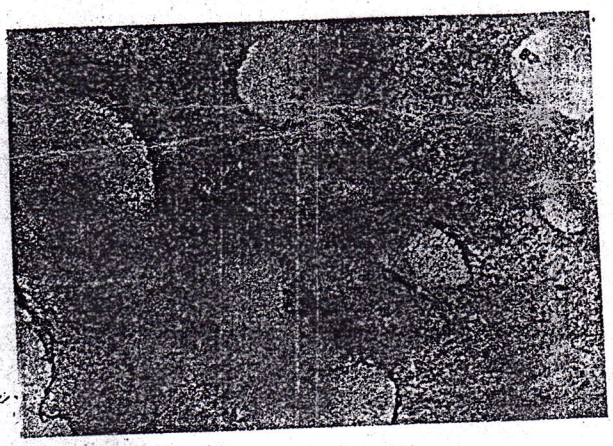


Pores, Fenestrations

behaviour of indigenously prepared natural coral skeleton, at 2nd, 4th and 6th week intervals in wistar rat mandible.

Materials and methods

The experimented corals were availed from the Centre for advanced studies-marine biology, Annamalai university. These were harvested from gulf of Mannar near Tuticorin and Mandapam in Tamilnadu, India. They belong to the phylum COELENTERATA and family PORITES LUTEA. They are reef farming with various individual coral animals or polyps, occupying cups or corallites in the massive skeleton.

The Exoskeleton is highly porous with 60% void volume the pores are of 100-130 µm in diameter and are interconnected by fenestration, consisting 99% calcium carbonate and 1% trace materials.

Coral implant preparation

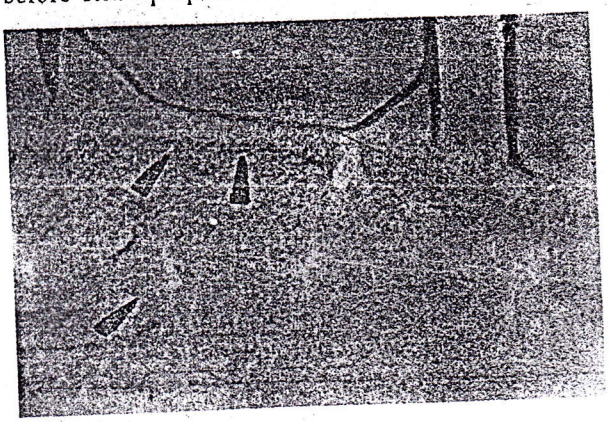
The preparation was done in the department of chemistry, Annamalai University. The principles of preparation are removal of the organic material and sterilizing the exoskeleton.

The coral skeleton was cut into slabs and the solid core is removed and the porous outer layer is prepared for the implant. The organic materials were removed by immersing the coral in 5% sodium hypochlorite for 48 hrs. then rinsing with deionized water for 48 hrs. dried and sterilized by autoclaving at 121 °C for 30 min and packed.

Surgical procedure

9 adult American breed wistar rats weighing about 200-240 gm were purchased from the Central Animal House - Department of Experimental Medicine and Surgery. Raja Muthaiha Institute of Health Science, Annamalai University. These animals were anaesthetised by injecting pentobarbitone sodium, 45 mg/kg. intraperitonially. Under asepetic condition, the ramus of the mandible was exposed through a submandibular approach, the coral implant was augmented to the bone and the wound was closed in layers with catgut and silk. Post operatively, Inj Ampicillin and Inj Ketrolac of calculated dose were administered intraperitonialy for 5 days and the period was uneventful.

Sacrifice was done using Chloroform. 3 rats at a time in the period of 2,4 and 6 weeks and the specimens were kept in 10% formalin for 48 hours before slide preparation.



2nd week specimen
Pores filled with connective tissue, Osteoblastic lining

Histological evaluation

The aim of the evaluation is to compare the microscopic structural similarity of the coral skeleton to that of bone and the histological behaviour of the implanted coral skeleton. The objectives of evaluation are

1) Inflamatory reaction.
2) Foreign body reaction
3) Encapsulation
4) Tissue in growth
5) Coral resorption
6) Bone replacement

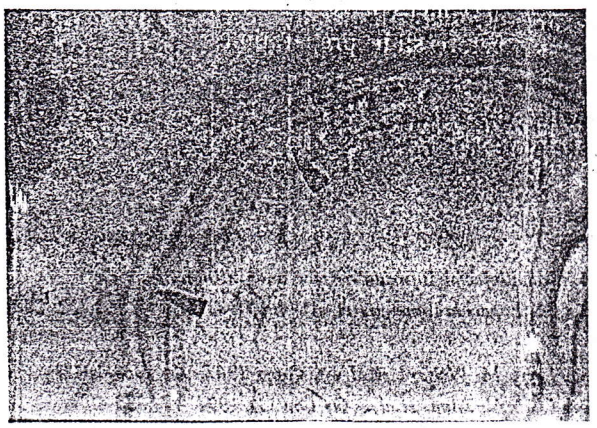
Coral skeleton

The undecalcified sections of the coral skeleton was prepared by individually grinding the specimen mounted on a glass plate.

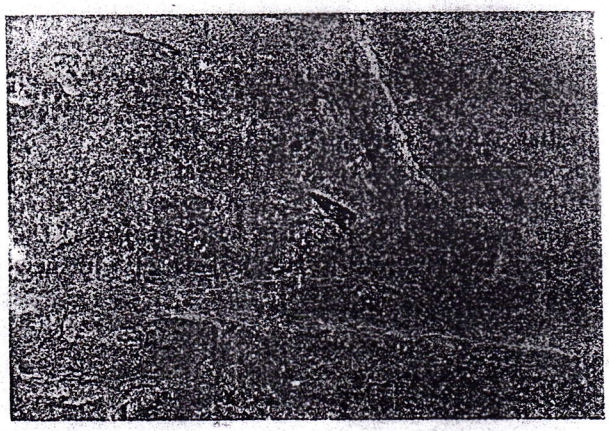
Magnification - 4x10X

Sections - horizontal, longitudinal

This highly porous structure exibitis, similarity to bone with lacunae like void spaces and fenestration inter connecting the spaces within the coral matrix.



4th week specimen
Active osteoblastic activity. Coral resorbtion and bone formation



6th week
Alternate areas of immature and matured bone formation

The decalcified animal specimens were prepared into 4 um thickness sections and stained with Eosin and Haematoxylin and viewed with a light microscope at a magnification of 4x10X.

2nd week specimen

1) Coral in Situ
2) No fibrous capsule formation
3) No inflamatory or foreign body reaction
4) Surrounded by connective tissue proliferating into the spaces (Pores)
5) Blood vessels ingrowth into pores.
6) Early attempt of bone formation

4th week specimen

1) Pheripheral lining of obsteoblast at the resorbed region of the coral skeleton
2) Intense bone formation

6th week specimen

1) Well defined laminar bone formation
2) Resorption of coral forming pheriphery for bone formation

Observatory conclusion

The behaviour of the natural coral skeleton on bone was satisfactory as documented by previous studies. There was no evidence of any acute or chronic inflamatary cells, there was no alteration in the vascularity of the implant region, connective tissue and blood vessel grow into the pores. The coral skeleton is resorbed and replaced with new bone.

Discussion

Natural coral skeleton as a bone substitute was introduced in the 1970's and were experimented and developed by many authors. At present "Biocorals" a ready-made, implantable biometerial obtained from the natural coral skeleton is available in France and distributed throughout the world.

An ideal bone substitute material should be biologically inert, readily available easily adaptable to the sites in terms of size and shape and replaceable by the host bone. Previous studies have demonstrated the potential of natural coral skeleton to achieve these goals. The paramount importance is the ability of these material to maintain their external form and volume thus superior to autogenous bone graft which usually gives unsatisfactory results.

Corals due to their porous nature allows rapid ingrowth of connective tissue and are stabilized at the grafted site which avoids any fixation techniques. There is no fibrous capsule encapuslation also.

The biocompatibility of the natural coral skeleton are determined by lack of inflammatory or foreign body giant cell reactions. These have been well documented and confirmed by this study.

The Histologic finding of owen bone formation in the pores of the implanted corals at 4th week and lamellar bone formation at 6th week confirms the results of previous studies conducted with this material in other skeletal sites. With longer duration of time the coral skeleton is completely resorbed and replaced with new bone by the processes of transformation of heterograft into a homograft.

Summary

The advantages of natural coral skeleton as bone substitute are as follows.

1. Natural
2. Widely available
3. Sturcturaley similar to bone
4. Easily preparable
5. Repeatebly sterilizable
6. 99% Calcium carbonate
7. Highly osteoconductive
8. Maintain form and volume
9. Totally biocompatible
10. Economic

Conclusion

The purpose of this study is to evaluate the efficiency of producing handy, user friendly, naturally occurring bone substitutable alloplastic material, indicates a bright positive future. Further study is being done to assess behaviour of natural coral skeleton in longer period of time.

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