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HISTOLOGICAL EVALUATION OF BONE HEALING WITH ALGIPORE BONE SUBSTITUTE MATERIAL

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ABSTRACT

The purpose of this study is the histological evaluation of the effect of Algipore bone substitute material on bone healing in bone defects in the mandible of rabbits.

The experimental study carried on eight rabbits. In each rabbit, two defects 5x5 mm in the body of the mandible near the lower border were created. In one defect we put Algipore material, the other defect left to heal spontaneously as a control. After one week, one month, three months, and six months postoperatively, specimens were taken for histological examination.

Histological findings showed that Algipore material is a safe, biocompatible to the tissues and osteoconductive.

INTRODUCTION

Dentistry has searched for the ideal material to place in osseous defects for many years. The autogenous bone graft has been considered the gold standard for many years. Many materials available in the markets for the purpose of repairing bone drfects, most of them claiming to be an idial material, but none has all the propereties of being the needed material. [1].

Advances in bone grafting are progressing with the evolution of biomatrials that permit the incorporation of osteoinductive and osteogenic proteins into osteoconductive scaffolds [2].

Algipore is one of the biologic bone substitute materials which is derived from marine algae. Its main uses were in the augmentation of alveolar ridge defect, maxillary sinus lifting, periodontal surgery, with dental implants [3] and in closure of oro-antral fistula [4]

Algipore originate from calcifying red algae. It is natural bone like, biocompatable, osteoconductive, and stable during bone formation.It has a unique pore structure that promotes new bone formation [5].

MATERIALS AND METHODS

Eight male indigenous whitish healthy rabbits were used for this experimental study. The average age of the rabbits was 12 months, each weighting 2.5 – 3 kg.

Bone substitute material:

Frios Algipore, with a grain size 0.3 -0.5 mm. (Friadent, Germany).

Algipore is a porous natural apatite derived from red algae. It consists of 100% inorganic, biocompatible calcium phosphate. It is manufactured by the hydrothermal convertion of the original calcium carbonate of the algae, and finally sterilized by gamma irradiation [6].

Study design:

All the eight rabbits were operated on. On one side of the mandible, by a submandibular approach the lower border of the mandible was exposed.

Two defects, about 5 mm in diameter for each, were created in the body of the mandible near the lower border in each rabbit. The distance between the two defects was about 5 mm.

One defect is filled with Algipore bone substitute material, the other defect was left to be filled by blood clot as a control.
The rabbits were sacrificed at 1 week, 1 month, 3 months, and 6 months after operation. Biopsies were taken for histologic examination.

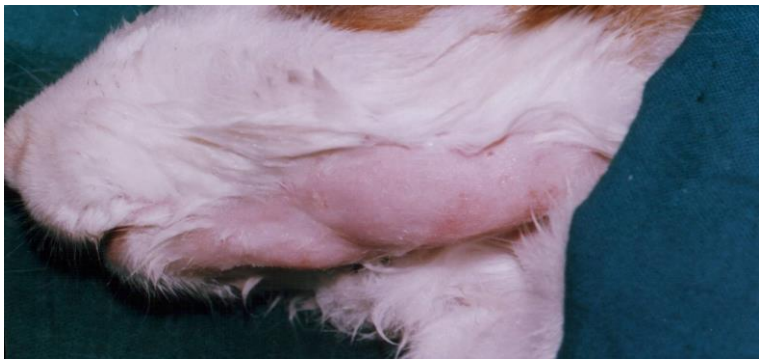


Figure 1 the field of the operation after shaving

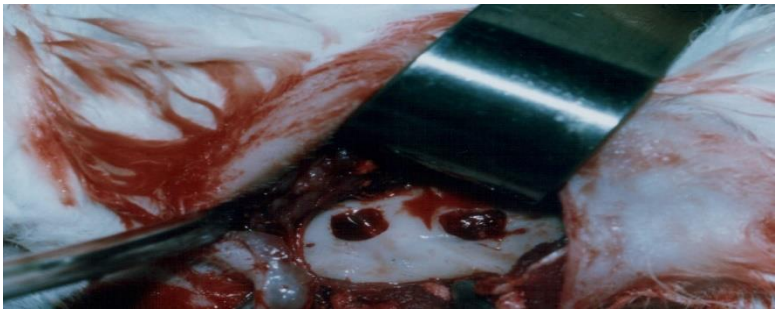


Figure 2 two defects were created in the body of the mandible

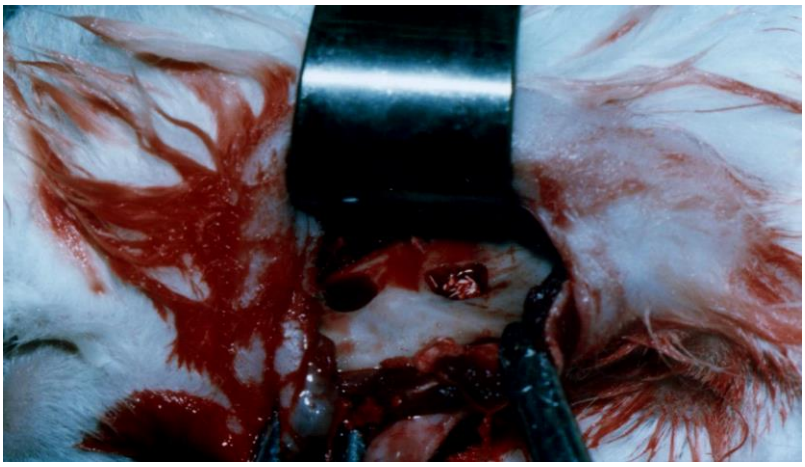


Figure 3 one defect was filled with Algipore, the other left to heal spontaneously

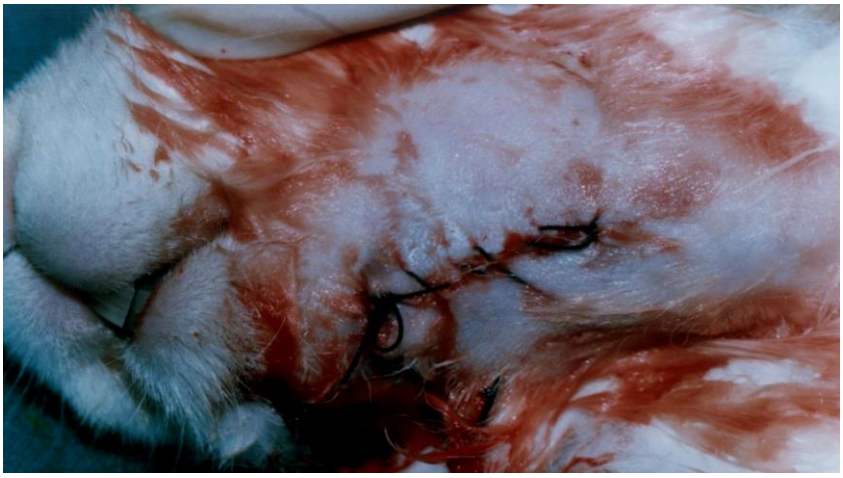


Figure 4 Suturing

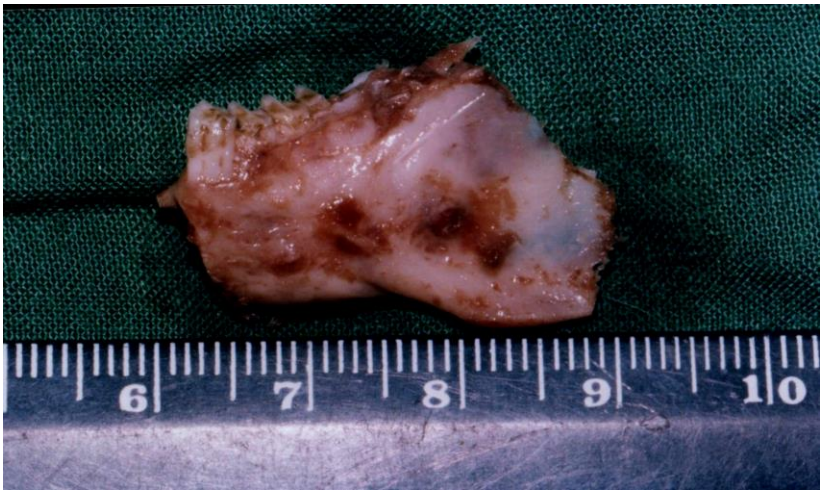


Figure 5 Specimen showing the two defects, one month after operation.

RESULTS

The histological examinations were done by two histopathologists and they noticed the following results:

One Week Postoperatively

Experimental Side (with Algipore)

The defect filled with blood clot and granulation tissue.The Algipore granules were clear within the defect. Many bone forming cells were clearly seen aroud the Algipore material, and new bone formation was evident at this stage. There were ingrowth of soft tissues into the pores of the Algipore material. There is no foreign body reaction around the Algipore material (Figures 6&7).

Control Side

The defect filled with blood clot and granulation tissue with early evidence of new bone formation **(Figures 8&9).**

One Month Postoperatively

Experimental Side (with Algipore)

New bone seen within the pores of the Algipore material and in the spaces surrounding the granules (Figure 10).

Control Side

The granulation tissue filling the defect started to be replaced with newly formed bone specially from the

periphery of the defect (Figure 11).

Three Months Postoperatively

Experimental Side (with Algipore)

Reduction in the size of the gap more than the control side and much more bone formation compared to the control side was seen. Dense bone seen surrounding the remaining Algipore granules. The bone was in direct contact with the Algipore material, no connective tissue capsule seen between the granules and the newly formed bone (Figures 12&13&14).

Control Side

Immature bone bounded by old bone was seen, note many osteocytes. Woven bone showing frequent, plump, irregularly arranged osteocytes (Figure 15).

Six Months Postoperatively

Experimental Side (with Algipore)

The defect nearly disappeared and filled by dense bone trabeculae. In some areas the gost of the Algipore granules seen within the material of the newly formed bone. No reaction to the Algipore material seen in the surrounding bone tissue (Figures 16&17).

Control Side

There are islands of dense bone formation within the defect and the defect was not closed completely (Figures 18&10).

One week Postoperatively

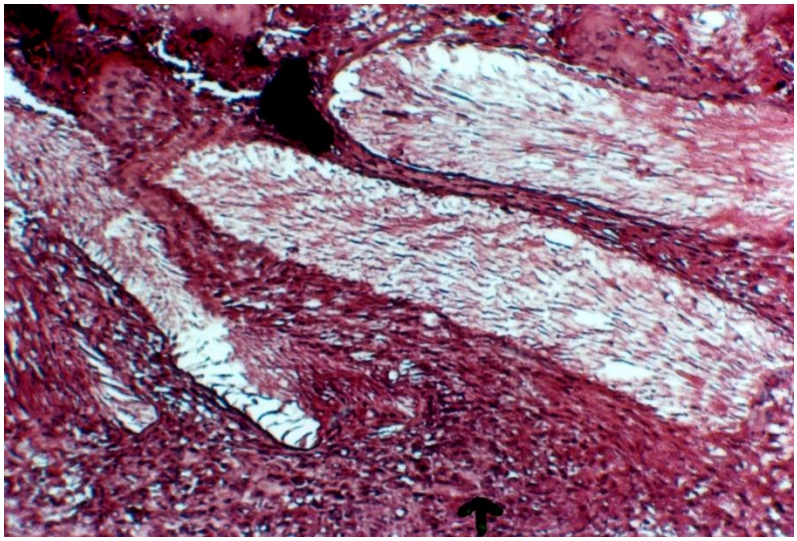


Figure 7: first week Postoperatively. The ingrowth of fibrovascular tissue within the Algipore granules. H&E stain, OM x40.

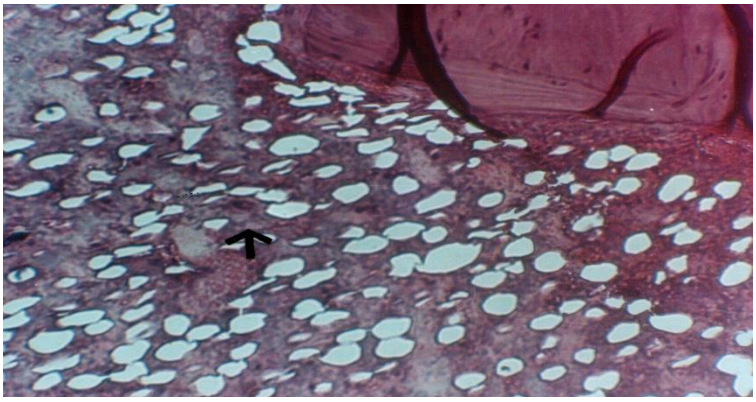


Figure 8: second week Postoperatively. Cont. defect with early new bone formation(arrow). H&E stain, orig. mag, x10.

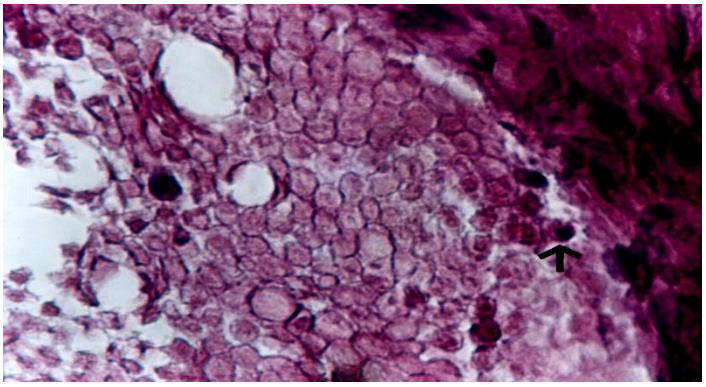
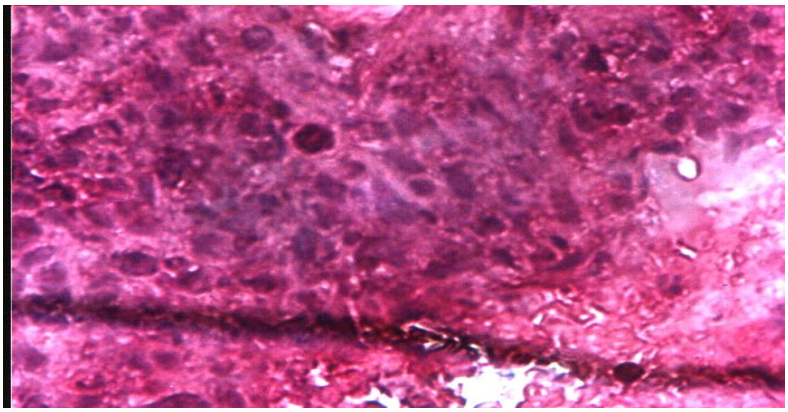


Figure 9: first week Postoperatively.Cont. defect. New osteiod tissue formation. H&E stain, orig. mag. x40.



One month Postoperatively

Figure 10: New bone formation inside the Algipore pores (arrow) H&E stain, orig. mag. X4

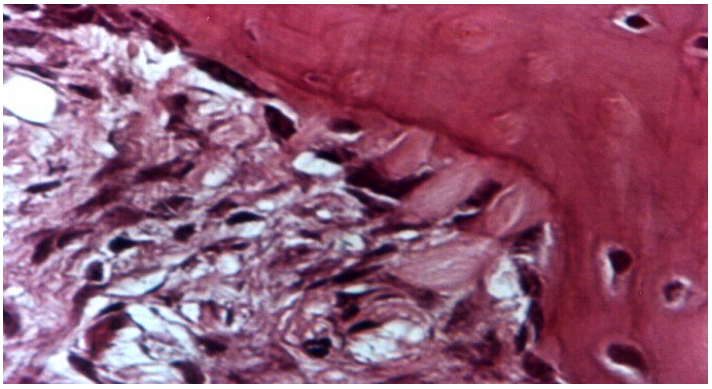


Figure 11 Cont. defect. New bone formation from the periphery.H&E orig.mag.X40.

Three months Postoperatively

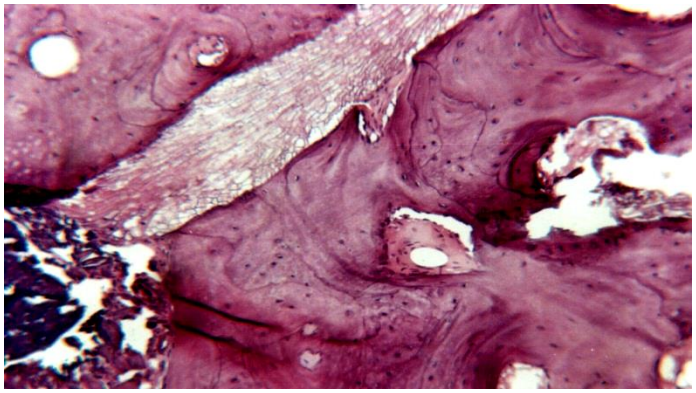


Figure 12: New bone in direct contact with Algipore granules.H&E stain, orig. mag. x10.

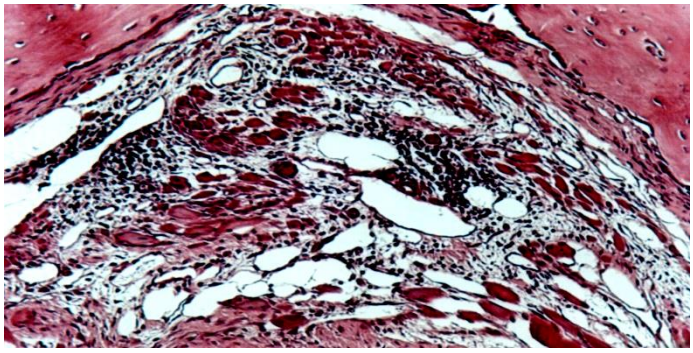


Figure 13: No fibrous tissue capsule around Algipore granules. H&E stain, orig. mag. X40.

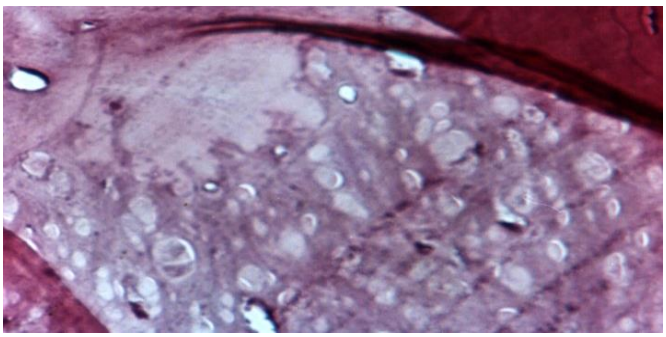


Figure 14: New bone around the Algiporee. H&E stain, orig. mag. X10

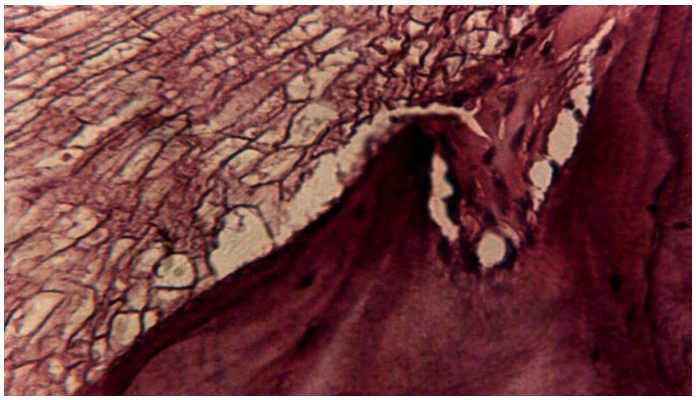
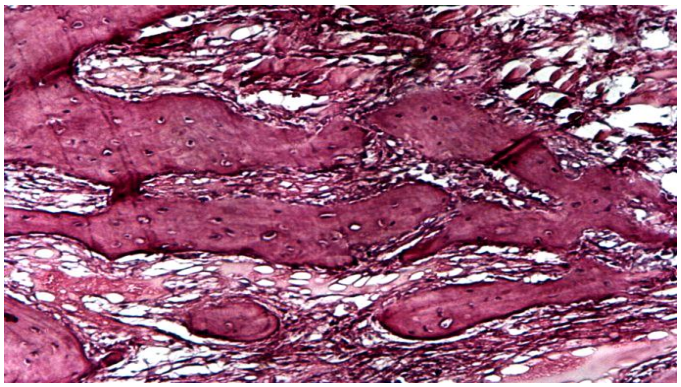


Figure 15: Cont. side. New bone formation within the defect. H&E stain, orig. mag. x10



Six months Postoperatively

Figure 16: Mature bone formation with resorption of the Algipore.H&E stain, orig. mag.x40

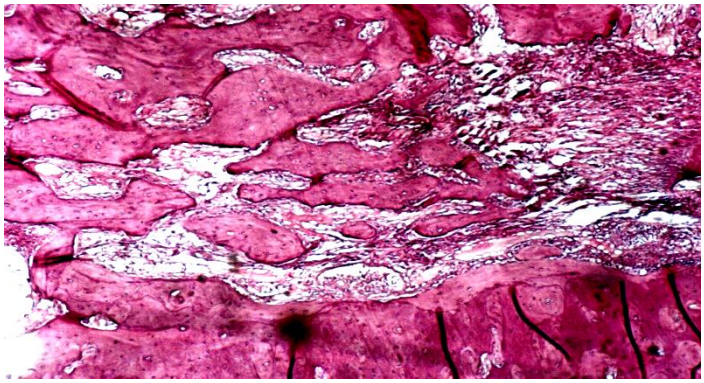


Figure 17: The gost of the Algipore material was seen with the new bone.H&E stain, orig. mag. x20.

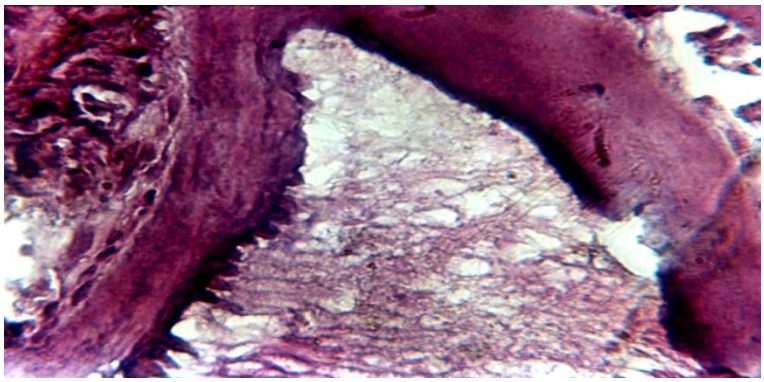


Figure 18: Cont. defect. Mature bone scattered in the defect.H&E stain,orig. mag. x10.

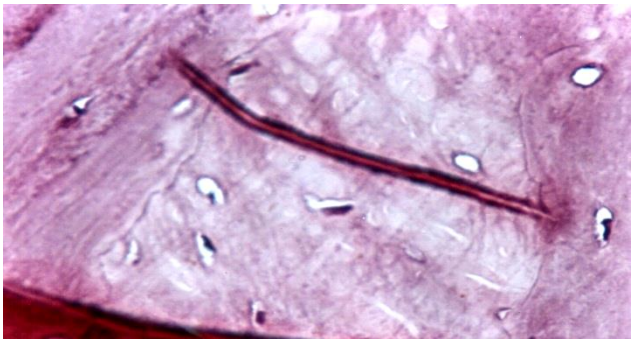


Figure 19: Cont. defect. The defect still not filled compeletely.H&E stain, orig. mag. x20.

DISCUSSION

In this study histological examination reveals that new bone formation started at one week after implantation of the Algipore material in the mandible of the rabbit. Although the control side also showed little evidence of new bone formation. This finding was agreed with [7, 8]

Algipore did not cause inflammentary reactions around implanted areas, and this is in agreement with [9].

Algipore enhances differentiation and deposition of matrix by the activation osteoblast and related genes [2].

The addition of blood to the algipore granules enhance the immune response, the vascularization and the regenerative potential of the process of bone tissue regeneration, and this is in agreement with [6].

Histological examination after one month of implantation of Algipore material in the defect in the mandible of the rabbit showed that osteoblast cells within the pores of the Algipore material and in the spaces around the granules. This finding illustrated the bioactivity and biocompatibility of the material and the effect of the porous structure of the granules which direct the tissues toward the pores (osteo conduction). This finding is in agreement with [7]. who found that vigorous bone formation extending deep into the HA particles and also in agreement with [10], who stated that the pores of a porous implant are important not only for soft tissue ingrowth, but also because they seem to affect bone formation within the implanted material.

Histological examination after three months revealed dense bone surrounding the Algipore granules and little resorption of the Algipore

material was started. The bone was in direct contact with the Algipore material, and no fibrous tissue capsule around the implanted material. This finding was in agreement with [11, 12, 4] And in disagreement with [13[. who observed that the newly formed bone was not directly in contact with implanted HA but surrounded by a thick connective tissue capsule.

While [14] stated that HA particles were surrounded by bone in direct contact at the periphery, and by fibrous tissue containing occasional giant cells and histiocytes in the central portion of the defect.

Foreign body reaction was not observed in histologic examination during all the interval periods.

Our findings were consistent with [16] who found osteoblastic cells were embedded in the intracapsular bone matrix, which indicate that xenograft particles are an osteoconductive scaffold and stimulate matrix deposition.

Six months postoperatively the defect implanted with Algipore was nearly disappeared and dense bone trabeculae with cancellous bone spaces were seen. The healing process looks faster than the control side. This is in agreement with [15].

The results indicated that Algibore bone substitute material is an osteoconductive material, biocompatible, nontoxic, did not elicit any inflammatory response or foreign body reaction.

Osteoinduction was difficult to be confirmed in our study, because it needs larger bony defects or bone formation in areas where originally there is no bone.

The fact that HA particles (Algipore) are closely surrounded by mature bone is very promising for the long term stability and success of the material, and this is in agreement with [17].

CONCLUSIONS

Histologic evaluation revealed that Algipore material enhanced bone healing by osteoconduction.
Histological studies demonstrated that Algipore was a safe implant material, biocompatible, nontoxic, and did not elicit any inflammatory responses or foreign body reactions.

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