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DENSITOMETRIC EVALUATION OF BONE HEALING WITH ALGIPORE BONE SUBSTITUTE MATERIAL

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Abstract:

The purpose of this study is clinical and radiographical evaluation of the effect of Algipore (bone substitute material) on the healing of tooth extraction sockets on human.

The clinical study carried on sixty patients with bilateral lower third molar teeth indicated for extraction. In one side we packed the socket after extraction by Algipore material, in the other side, the sockets were left to heal spontaneously as a control.

The healing of the sockets were evaluated by a transmission densitometer for the X-ray films (Periapical and Orthopantomogram), at one week, one month, three months, and six months postoperatively.

The densitometric values showed that the bone formation in the experimental side was faster than the control side. And the transmission densetometer is a reliable method to evaluate the progress of bone healing in tooth extraction sockets.

Keywords:

INTRODUCTION

Dentistry has searched for the ideal material to place in osseous defects for many years.M'any materials available in the markets for the purpose of repairing bone defects, most of them claiming to be an ideal material, but none has all the propereties of being the needed material[1].

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

Algipore is one of the biologic bone substitute material which is derived from marine algae. Its main uses were in the augmentation of alveolar ridge defect, filling of extraction sockets, 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

The clinical trial was conducted on sixty patients attending the clinic for the surgical removal of a bilaterally impacted mandibular third molars under local anesthesia.

Patient selection:

1. The criteria for participating in the study was bilaterally impacted mandibular third molars, that were indicated for surgical extraction after careful judgement by preoperative clinical and radiographic examination.
2. Patients should be willing to take part in the study and follow all the instructions and coming back during the follow up periods.
3. The indications for bilateral lower third molar extraction were crowding of the teeth (orthodontic reasons) (**20**) patients, recurrent pericoronitis (**24**) patients, caries (**12**) patients , and periodontal diseases (**4**) patients.
4. The patients were selected irrespective of sex or economic status, the sample included (**22**) males and (**38**) females. The age range was **17-38** years.
5. The medical condition for each patient was carefully recorded to exclude any medically compromised patient who was unfit for the surgical removal of impacted lower third molars.

Study design:

1. The healing of the tooth extraction socket was chosen to evaluate the effect of Algipore bone substitute material on bone healing.

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2. Because many patients had a bilateral lower third molars which needs extraction, those teeth were chosen for this study.
3. For each patient both lower third molars were extracted surgically, The time interval between the two operations for the same patient was 1-3 weeks.
4. In one side the socket of the extracted lower third molar was filled with Algipore bone substitute material. While in the other side the socket was left to be filled with blood and to heal spontaneously as a control.
5. The Algipore material was used in the first operation in thirty patients and was used in the second operation (other side) in the other thirty patients, to avoid errors in the clinical evaluation of the postoperative complaint
6. Comparisn between the two sides for every patient was done by clinical and radiological examinations.
7. Radiographical assessment of the healing of the extracted socket was done by measurement of the X-ray film density by a transmission densitometer (figure 1)

Figure 1. Transmission densitometer

Radiological examination: Pre-operative periapical and/or OPG views were used to determine the depth, direction of the impaction, shape and size of the roots, the relation of the roots to the inferior dental canal, adjacent second molar, the structure of the investing bone, and any pathologic lesion associated. Preoperative X-ray was illustrated in **(Figure 2).**

1. Post-operative radiographic examination by periapical and/or OPG views was done :
   a. One week after extraction.
   b. One month after extraction.
   c. Three months after extraction.
   d. Six months after extraction.
2. Densitometric evaluation of all the radiographs was done to the :
   a. Experimental side (sockets filled with Algipore material).
   b. Control side (sockets without any material , normal healing)
   c. Alveolar bone near the sockets.

To avoid errors of single reading, each densitometric reading was taken at least three times at different areas of the same socket and a mean of the readings was taken.

Also the density of the alveolar bone was measured at different points of the same X- ray film and a mean was taken to compare the sequence of healing.

The density of the processed unexposed film was also measured to obtain the base and fog densities **(Figure 3)**.

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Figure 2. Preoperative OPG

Figure 3. The processed unexposed Periapical film.

Bone substitute material: Frios Algipore:

Algipore is a porous natural apatite derived from red algea It is prepred by the hydrotherml convertion of the original calcium carbonate of the algea in the presence of ammonium phosphate at approximatly 700 c resulting in a mainly HA based material, which become finally sterlized by gamma irradtion. It is available in granules with particle size of 0.3-2.0 mm and pores in the range of 5-10 micrometer(6).

Surgical procedure:

Figure 4. The socket after tooth extraction.

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Figure 5. Augmentation of the socket with Algipore material.

Figure 6 Algipore granules soaked with blood after gentle adaptation.

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Figure 7 Flap repositioning to cover Algipore granules and suturing.

Statistical analysis

1. Descriptive statistics :

Tables, figures, and numerical values were used in this study for the sake of describing the variables.

2. Inferential statistics :
   a. T- Test for testing the significant differences between two mean values.
   b. Chi- square test used for the statistical analysis between two groups when there were no mean values or standard deviation.

RESULTS

Radiological evaluation :

All the X-ray films were examined first by X-ray viewer. It was difficult to obtain a perfect results from the examination of the X-ray films by the viewer, because the interpretation was not easy and the differences between the experimental and the control sides were hardly seen.

Densitometric evaluation:

Table(1) and **Figure(8)** summerize the densitometric values of the experimental sockets (sockets filled with *Algipore* material), control sockets (sockets left to heal spontaneously), and the alveolar bone around the sockets.

The mean values were considered to the following intervals, **1** week, **1** month , **3** months, and **6** months postoperatively.

Table(1) Distribution of Densitometric values of X-ray films for experimental side , Control side, and alveolor bone to (60) patients:

	Experimental side		**Control side**		**alveolor bone**	
	Mean	**SD**	Mean	**SD**	**Mean**	**SD**
1 week post op.	1.411	0.3552	1.563	0.382	0.995	0.241
1 month post op.	1.316	0.219	1.374	0.372	0.934	0.236
3 months post op.	1.111	0.241	1.282	0.277	0.897	0.231
6 months post op.	1.085	0.309	1.199	0.300	0.969	0.327

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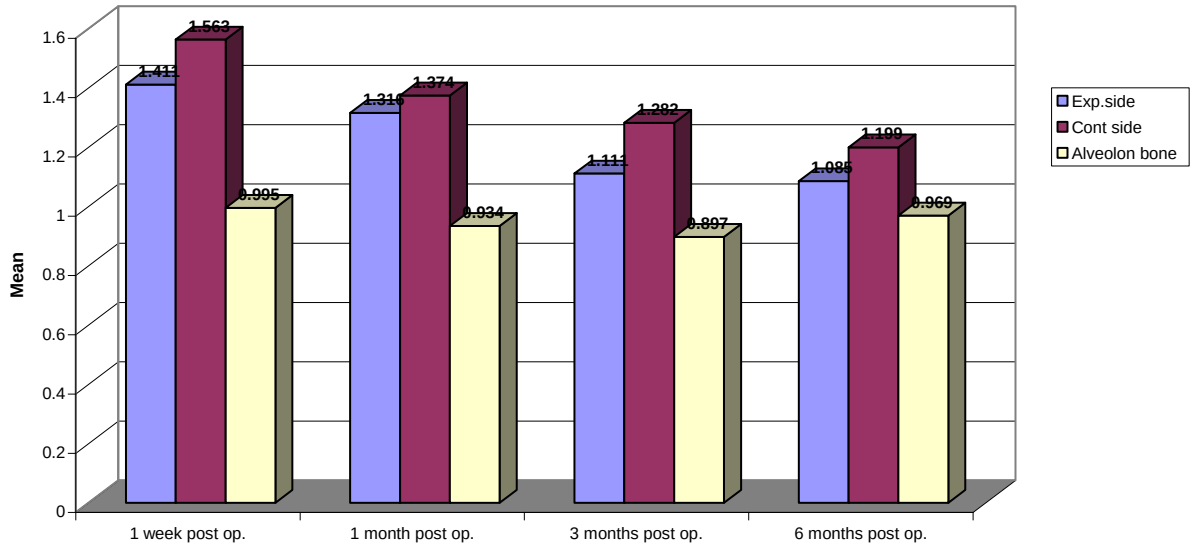

Figure 8. Means of Densitometric Values of the Exp., Cont. & Alveolar Bone

1 week postoperatively:

the differences between the experimental and the control sides were highly significant **P< 0.0001**. Also the differences between the experimental side and the alveolar bone around the socket were highly significant **P< 0.0001(Figure 9).**

- ***1 month postoperatively :***

the differences between the experimental and the control sockets were non significant **P> 0.05** . while the differences between the experimental side and the alveolar bone were HS **P< 0.0001(Figure 10).**

- ***3 months postoperatively :***

the differences between the experimental and the control sides were HS **P< 0.0001** . Also the differences between the experimental socket and the alveolar bone were HS **P< 0.0001(Figure 11).**

- ***6 months postoperatively:***

the differences between the experimental and the control sides were HS **P< 0.0001**. Also the differences between the experimental side and the alveolar bone were HS **P< 0.0001(Figure 12).**

The differences in the densitometeric values between the experimental sides of **1** week and **1** month were significant **P< 0.05** and between **1** week and **3** months were HS **P< 0.0001** and between **1** week and **6** months were also HS **P< 0.0001(Tables 2).**

The mean densitometric values of the Algipore material alone was **1.284** and that of the X-ray film around the granules was **1.362 (Figure 13).**

The densitometric value of the processed unexposed film was **0.198** .

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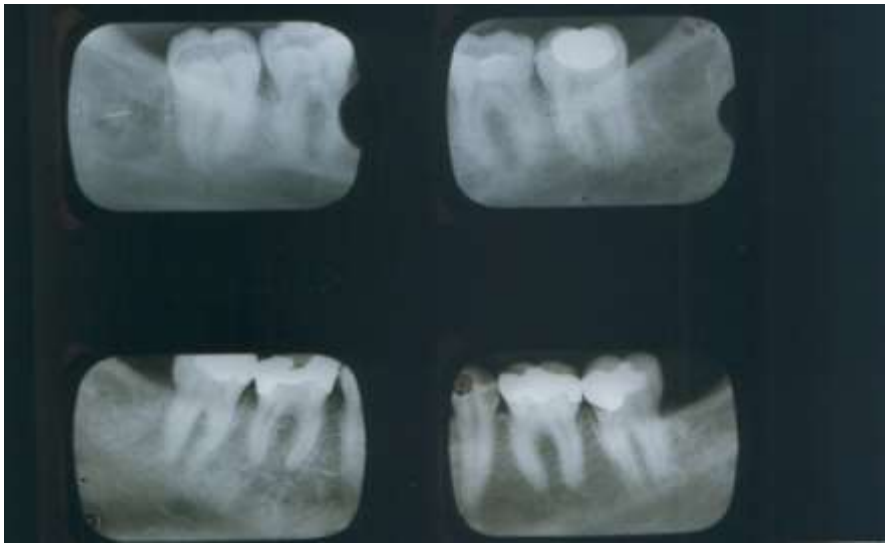

Figure 9. 1 week Postop., A&C Exp. Sockets with Algipore B&D Cont. Sockets

Figure 10. 1 Month Postop. R. Side Exp., L. Side Cont.

Figure 11. 3 Months Postop. A&D Exp., B&C Cont.

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Figure 12. 6 Months Postop. R. Side Cont., L. Side Exp.

Table 2. Comparison of densitometric values between Exp., Cont. sides and alveolar bone during the 4 periods:

	Experimental side	**Control side**	**alveolor bone**
1 week post op.	***P<0.0001 HS***	*P<0.0001 HS*	*P<0.0001 HS*
1 month post op.	***P>0.05 NS***	*P<0.0001 HS*	*P<0.0001 HS*
3 months post op.	***P<0.0001 HS***	*P<0.0001 HS*	*P<0.0001 HS*
6 months post op.	***P<0.0001 HS***	*P<0.0001 HS*	*P<0.0001 HS*

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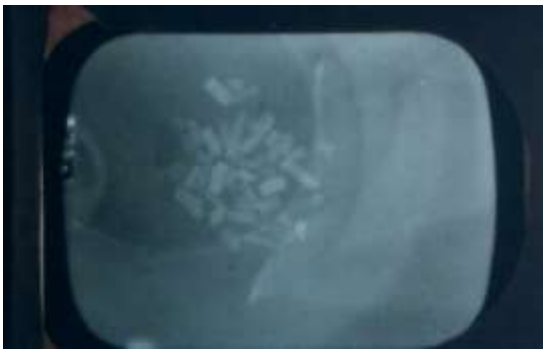

Figure 13. X-ray Film for the Algipore Material alone

5. DISCUSSION

In the present study, Algipore material was used in the extraction sockets of bilaterally impacted lower 3rd molars to evaluate bone healing after tooth extraction accuratly.

Because many authors used single or multiple extractions in a number of patients and used some as a study sockets and others as a control sockets, and this may affect the results obtained because of the differences in the position of the teeth (anterior or posterior, upper or lower), and in the indication of extraction (pulpitis, periodontal diseases, periapical pathology, prosthetic and orthodontic requirements… etc). All these factors in addition to individual variations affect the healing process of the extracted socket. These points were agreed with ***(7),(8),(9) .***

The Algipore material was well tolerated by hard and soft tissues and does not seem to evoke any inflammatory responses. Clinical examination of the tissues covering the implanted sockets was seen healthy during the follow up periods. This is in agreement with ***(7),(10)(11).***

Radiological Evaluation

Every X-ray film was examined first by X-ray viewer to evaluate thoroughly the healing process of the sockets. This method was not enough to detect the changes, in the X-ray films, that is why we used the densitometric evaluation for the X-ray film by the transmission densitometer.

The densitometer reads the degree of blackness in the X-ray film, when the densitometric reading is relatively high it means more radioluscent (darker), and when the reading is relatively low this means that the film is more radio opaque. For example from table 1 in the results, at 1 week postoperatively the mean value for the experimental side was (1.411) and the mean value for the control side was (1.563), this means that the experimental side was more radio opaque. Also both sides were more radioluscent than the alveolar bone which have a mean value of (0.995).

The results of the densitometric evaluation showed that the differences between the experimental and control side in the 1 week, 3 months and 6 months postoperatively were highly significant and in 1 month postoperatively was non significant.

From the bar chart of the densitometric values (Figure 4-4) it was clearly seen that the values were gradually reaching toward the values of the alveolar bone around the sockets, and the experimental side values were nearer than the control sides toward the alveolar bone.

The densitometric values of the alveolar bone around the sockets in the 4 postoperative periods were nearly equal (0.995, 0.934, 0.897, 0.969, in 1 week, 1 month, 3 months and 6 months respectively).

These results demonstrated that the healing process was gradually going on in both the experimental and the control sides, and in the experimental side was slightly faster than the control sides. These results also demonstrared that Algipore was a bioactive material which means, the setting up of chemical links between it and the surrounding bone. This is in agreement with ***(7).***

The examination of the X-ray film of the Algipore material alone revealed that it was slightly radio opaque and hardly could be seen by the X-ray viewer. This finding was confirmed by the densitometric evaluation which was (1.284) for the Algipore granules and (1.362) for the X-ray film around the granules. For this reason the slight radio opacity of the Algipore material in the experimental side had very little effect on the overall results of the densitometric values. Besides the Algipore material in the sockets was surrounded by thick cortical bone which minimize the effect of the slight radio opacity of the Algipore material on the densitometric values.

The densitometric value of the processed unexposed film was 0.198 which is within the accepted values, and did not affect the results. This is in agreement with ***(12)(13)(14)(15).***

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CONCLUSION

The clinical study has demonstrated that Algipore material was useful in tooth socket augmentation and enhancement of bone healing, for future implant supported or conventional prostheses.
The measurement of the density of the X-ray film by the transmission densitometer was a simple and reliable method to follow the process of bone healing.

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