Low Intensity Laser Versus Synthetic Bone Graft To Increase Bone Density After Enucleation Of Large Cystic Lesions Of Jaws

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Abstract: *Material and Methods:* This study included 27 patients of both sex (17 males & 10 females) aged 20 - 48 years. They were divided into 3 groups, each group contained 9 Patients. All patients in all groups were selected to have large cystic cavities in their dental arches of different etiological factors, ranged in diameter 1.5 – 3.5 cm, and not approaching any vital structures. They underwent surgical enucleation of these cystic lesions. Patients of group (I) have received bone substitute in form of Algipore granules that were packed inside the bony cavities of enucleated cysts till complete filling. While Patients in group (II) have not received any grafting materials after cysts enucleation, but low intensity diode laser was applied to all of them in six sessions for each patient. Patients in group (III), control group, have not received any grafting materials after cysts enucleation. Radiographic evaluation of all patients was performed using digital radiography system (Digora). Radiographs were taken preoperatively and at intervals of 1 day, 6 weeks, 3 months and 6 months post surgically. The mean bone density at the same region of opposite side was also measured for comparison. *Results:* It was found that there was a significant higher bone density in Algipore group than other two groups at 1 day and 6 weeks time intervals, while there was no significant difference between Algipore and Laser groups at 3 months and 6 months post surgically. But both groups showed significantly higher bone density than control group at these 3 & 6 months time intervals. Furthermore, the bone density was significantly higher in Laser group than control group at 6 weeks time interval. In control group, there was no significant difference in bone density between all time intervals. In group I & II, there were significant increase in bone density in all time intervals compared with preoperative density, but, there were no significant difference in bone density between different time intervals in control group. *Conclusion:* Algipore (CORALS) can be a dependable bone substitute material for grafting bony defects in both jaws, Low intensity laser has also the ability to significantly increase bone density of empty cavities of jaws after enucleation of large cysts, so, it is preferred than Algipore specially with cases having infected lesions .
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Key words: Bone substitutes, Diode laser, Cyst enucleation

1. Introduction

Large bony spaces left after enucleation of large cystic cavities of the Jaws represent a questionable issue for bone grafting procedures. To increase the bone density, low intensity laser was found to have a significant rule for this purpose too, *Khadra et al., (2004)*.

Algipore was studied against Low Intensity Diode Laser to fulfill the aim of increasing bone density for these bony spaces.

Roux et al (1988) reported that Corals have the advantage of being cheap, easily sterilized, inert (99% of calcium carbonate), biodegradable and well re-ossified. They shorten surgical procedures by avoiding the use of iliac and/or costal grafts. No infectious complications have been noted. *Patat and Guillemin (1989)* mentioned that Experimental studies commenced in 1977 and human clinical applications commenced in 1979, have largely demonstrated the biocompatibility of the coral material and its entirely original nature. This biomaterial is progressively and totally replaced by newly formed bone with the characteristics of the recipient bone (after completion of the restoration process). *Begley et al (1995)* in a comparison between Corals and others said that “a layer of what

appeared as dense calcification was seen around the coral implant. Coral elicited no marked inflammatory response, and this was attributed to the negligible amounts of protein present in these materials. *Roux et al (1995)* mentioned that "Madreporic Coral graft implants can be recommended as bone substitute in cranial base surgery: 1) The material simplifies the surgical procedure; 2) Harvesting of autologous bone is no longer necessary; 3) Transmission of infections like AIDS, Hepatitis C or Creutzfeld-Jacob-disease can be avoided with certainty". *Demers et al (2002)* in their review for Corals as a bone substitute revealed that the structure of the commonly used coral, is similar to that of cancellous bone and its initial mechanical properties resemble those of bone, they are biocompatible, osteoconductive, and biodegradable at variable rates, and they added "When applied appropriately, natural coral exoskeletons have been found to be impressive bone graft substitutes. *Turhani et al (2005)* concluded that the results of their study showed that Algipore obtained from calcified red algae support the proliferation and differentiation of human osteoblast-like cells on its surface.

Rochkind et al (2004) ; Fukuhara et al (2006) ; Pretel et al (2007) and De Oliveira et al (2008) all revealed that the use of infrared LLLT directly to the injured tissue showed a biostimulating effect on bone remodelling and tissue repair by stimulating the modulation of the initial inflammatory response and anticipating the resolution to normal conditions at the earlier periods of time.

Saito et al (1997) ; Khadra et al (2004) ; Nissan et al (2006) ; Lirani-Galvão et al (2006) and Miloro et al (2007) all suggested that laser therapy of low power density is effective on bone formation and the bone healing process by affecting calcium transport during new bone formation .

Kusakari et al (1992) and Stein et al (2008) revealed that, the LLLT appeared to increase bone-forming activity of osteoblasts or may directly act on osteoblast-precursors and biostimulate osteoblast-like cells for enhancement of bone regeneration. *Vladimirov et al (2004)* said that "Laser therapy based on the stimulating and healing action of light of low-intensity lasers (LLLT), along with laser surgery and photodynamic therapy, has been lately widely applied in the irradiation of human tissues in the absence of exogenous photo-sensitizers. Besides LLLT, light-emitting diodes are used in phototherapy (photo-biostimulation) whose action, like that of LLLT , depends on the radiation wavelength, dose, and distribution of light intensity in time. *Dörtbudak et al (2000)* concluded that, irradiation with a pulsed diode soft laser has a bio stimulating effect on osteoblasts, which might be used in osseointegration of dental implants. In bone grafting procedures, many methods were used for measurement of bone density as dual X-ray absorptiometry, *Bettin et al.,(2003); Johansson et al.,(2004); Kastl et al.,(2005); Marcen et al.,(2005)*, Peripheral quantitative computed tomography (pQ-CT), *Butterfield et al.,(2005),* Micro-computed tomography (micro CT), *Lu and Rabie (2003)& (2004); Mankani et al.,(2004)*, Cutting torque measurements, *Kastl et al.,(2005)* and many other techniques. *Sivarajasingam et al (2001)* have measured Optical density of iliac and tibial grafts using a computerized densitometer, and compared them at 6 days, 6 weeks, and 3 months. *Mankani et al (2004)* concluded that the use of quantitative CT offers a practical approach for the non-invasive determination of new bone formation in mineralizing bone marrow stromal cells and hydroxyapatite-tricalcium-phosphate (HA-TCP) transplants. *Beltrame et al (2005)* have presented an innovative calibration algorithm for a semi-quantitative analysis of non-standardized digitized X-ray images to investigate the progression of the new bone deposition and the osteo-integration at the bone-implant interface. *Sanchez et al (2005)* have measured the bone mineral density (BMD) and bone mineral content (BMC) by peripheral dual X-ray absorptiometry densitometer. *Thorwarth et al (2005)* used micro-radiography analysis for mineralization of autogenous bone grafts harvested from different sites and concluded that the differences in mineralization depending on the origin of autogenous bone, even after 6 months, these values could still be correlated to the transplants origin. *Vossen et al (2005)* have studied Bone quality pre- and post-transplant using other modalities by measuring acoustic velocity and density and by calculating elastic coefficients.

Aim of this study was to evaluate low intensity laser for increasing bone density in large bony cavities created by enucleation of large cysts of the jaws and also to compare between Low Intensity Diode Laser and Corals as a bone substitute grafting material for filling these large bony cavities. In addition we aimed

to compare between the effect of grafting, non-grafting and Laser application procedures on bone densities of these cavities.

2. Material & Methods

2.1. Material:

2.1.1. The Studied sample:

This study included 27 patients of both sex (17 males & 10 females) aged 20 - 48 years, they were divided into 3 groups:

Group I *(Algipore Group):* Contained 9 patients (4 males & 5females) of average age 29.8 years.

Group II *(Laser Group):* Contained 9 patients (3 males & 6 females) of average age 31.85 years.

Group III *(Control Group):* Contained 9 patients (5 males & 4 females) of average age 30.95 years.

All patients in all groups were selected to have large cystic cavities in their dental arches of different etiological factors, ranged in diameter 1.5 – 3.5 cm. and not encroaching any vital structures. ***(Figure 1)***

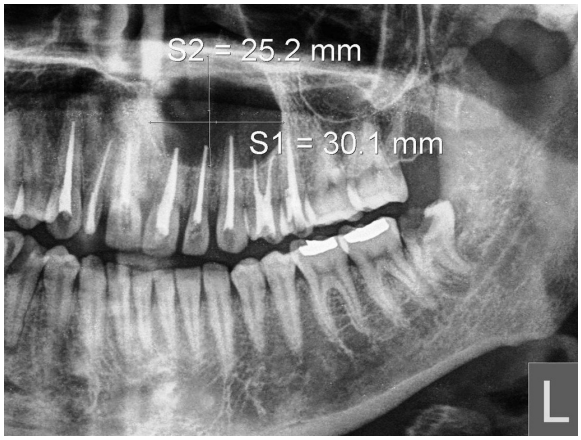

Figure 1: Large cystic lesion of left Maxilla

All patients underwent surgical enucleation of these cystic cavities using either pyramidal flaps or semi-lunar flaps according to the location of the cyst in relation to the crest of the ridge. ***(Figure 2)***

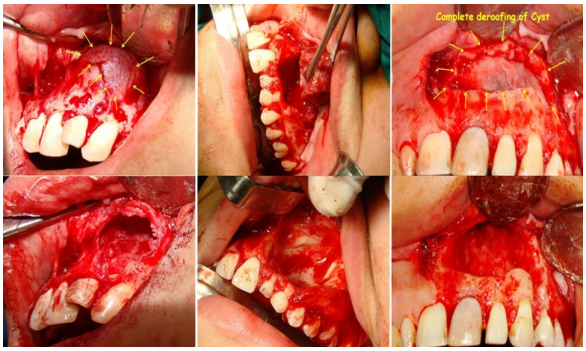

Figure 2: Surgical enucleation of lesions in 3 cases representing the 3 groups (Above: are lesions in place & Below: are Cavities after lesions enucleation)

2.2. Methods:

2.2.1. Root canal treatments:

Root canal treatments were performed to the related affected teeth before or during the surgical procedures.

Patients in group (I) have received bone substitute graft in form of Algipore granules that were mixed with a blood sample from the patient , then, packed inside the bony cavities of enucleated cysts till complete filling of these cavities. ***(Figure 3)***

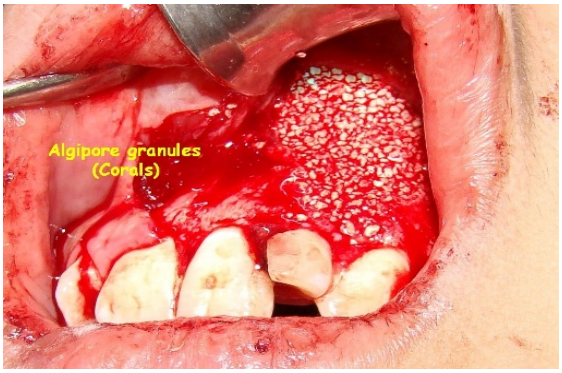

Figure 3: Algipore granules are packed inside the cavity of enucleated cyst

Patients in group (II) have not received any grafting materials after cysts enucleation, but Low Intensity Diode Laser was applied to bony cavities of all of them in six sessions for each patient, day after day starting from 1 day post surgically.

2.2.2. Laser Procedure:
Quanta system apparatus was used, the wave length used was 980 nanometres (nm), the power was 0.1 watt (W), and the laser beam emission was in continuous mode. ***(Figure 4)***
The fibre used with this device was 320 micron (µm).

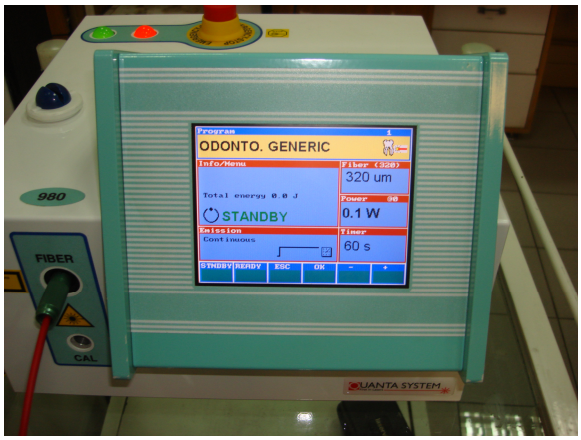

Figure 4: Diode Laser Device

Diode laser application was done with the fibre placed in direct contact with the tissues. Laser beam has been applied to the bony cavity labially and palatally, the time of each application was 60 seconds for each 1cm width of the cavity. **(*Figure 5)***

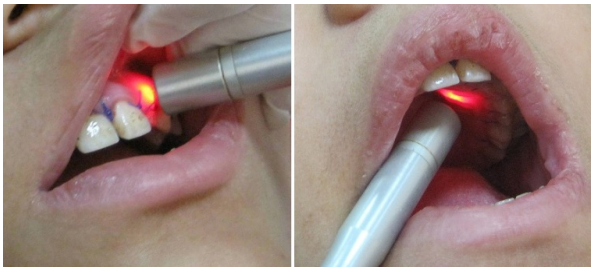

Figure 5: Application of Diode laser intraorally (labially & palatally)

The total energy for each 1cm. width of the cavity was 12 Joul (J), (6 Joul labially and 6 Joul palatally) as: **Joul (J) = Watt (W) × seconds (S)**
Green eye glasses were worn by doctor and patient during laser application for eye protection.

Patients in group (III) have received neither grafting materials nor Laser application after cysts enucleation, they represented the Control group.
Suturing of the flaps for all patients was performed using 3-0 black silk suture without placement of any guided bone regeneration membranes, then, postoperative regimen of medications was prescribed for all the patients. ***(Figure 6)***

Figure 6: Suturing of the flap (Up) & 6 months postsurgical (Down)

2.2.3. Radiographic evaluation:
Radiographic evaluation of all patients was performed using digital radiography system (Digora) by Soredex Orion Corporation version 1.51. Radiographs were taken preoperatively and at time intervals of 1 day, 6 week, 3 months and 6 months post-surgically. All radiographs were taken using long cone parallel technique with the help of bite blocks to provide standardization of images or digital panoramic radiographs were obtained. The mean bone density at the same region of opposite side was also measured for comparison.
The density measurement window displayed the radiographs, and a rectangular area is marked on the image in the area of the bony defects and area measuring was performed. The mean density of pixels within the area of cavity was recorded and the other normal side too. Results were displayed as numeric statistical information, as a histogram showing density distribution, and a density profile. ***(Figure 7)***

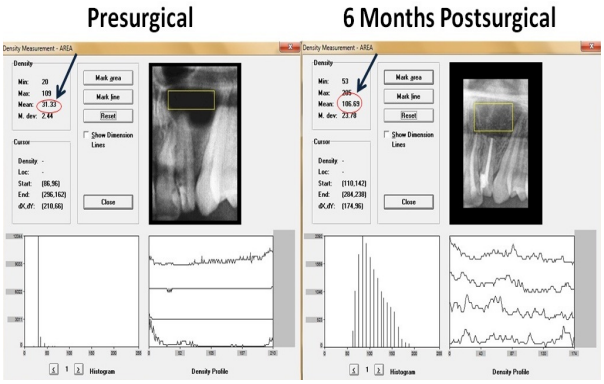

Figure 7: Measurement of bone density by DIGORA

2.2.4. Statistical analysis:

The data were tabulated and statistically analyzed using 2 ways ANOVA.

3. Results

At one day postoperatively: bone density in the Algipore group showed significantly higher levels than both laser and control groups whose values were insignificantly different.

At six weeks postoperatively: Algipore group still showed significantly higher bone density than both laser and control group, with another statistically significant higher bone density in laser group than control group.

At three months postoperatively: there was no statistically significant difference between bone density values of Algipore and Laser groups, while both showed statistically significant higher levels than control group.

At six months postoperatively: there was no statistically significant difference between bone density values of Algipore and Laser groups, while both showed statistically significant higher bone density than control group. ***(Figure 8)***

In the laser group: there was no significant change in the bone density between preoperative and one day values, while there was statistically significant increase from 1 day to 6 weeks, from 6 weeks to 3 months and from 3 months to 6 months time intervals.

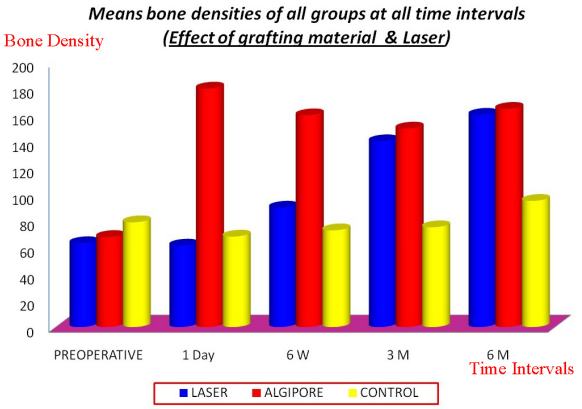

Figure 8: Mean values of Bone densities in all groups at different time intervals

In the Algipore group: there was statistically significant increase from preoperative to 1 day time intervals, there was statistically significant decrease from 1 day to 6 weeks postoperative time intervals, followed by insignificant decrease from 6 weeks to 3 months, then there was statistically significant increase from 3 months to 6 months postoperatively.

In Control group: the was statistically insignificant decrease from preoperative to 1 day postoperative bone density values, followed by statistically insignificant increase from 1 day to 6 weeks, and another insignificant increase from 6 weeks to 3 months time intervals, then there was statistically significant increase from 3 months to 6 months. ***(Figure 9)***

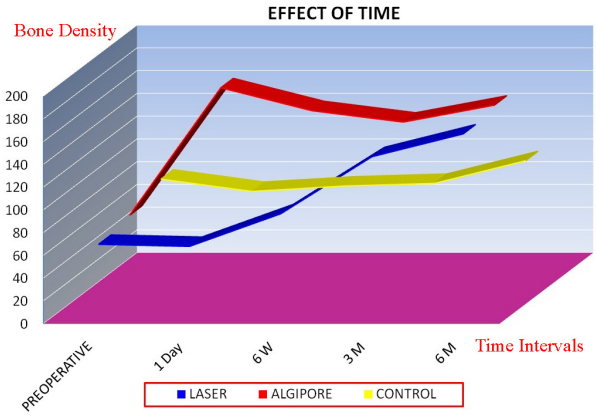

Figure 9: Effect of time on bone density in all groups throughout follow up periods

Table (1): Original Statistical analysis of 2 ways ANOVA

ANOVA (2 Ways)						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Sample *(Time)*	72419.1	4	18104.78	123.8715	1.23E-41	2.447237
Columns *(Material)*	101236.6	2	50618.28	346.3264	1.43E-50	3.071776
Interaction	75089.51	8	9386.189	64.21959	9.25E-40	2.016428
Within	17538.93	120	146.1577			
Total	266284.1	134				
LSD (at p< 0.5) LSD (at p< 0.1)	11.246 14.915					

Difference was considered statistically significant at $p < 0.1$

Table (2): Means of bone densities readings of all groups at all time intervals to study the effect of time and the effect of technique

		LASER	ALGIPORE	CONTROL
Preoperative	**Mean**	**63.45**	**68.13**	**79.23**
	variance	111.61	236.28	37.89
1 Day	**Mean**	**61.63**	**180.31**	**68.41**
	variance	21.44	365.29	64.24
6 Weeks	**Mean**	**90.33**	**160.11**	**73.14**
	variance	79.48	180.83	57.53
3 Months	**Mean**	**140.52**	**150.10**	**75.47**
	Variance	62.03	78.05	52.68
6 Months	**Mean**	**160.54**	**165.00**	**95.40**
	Variance	89.41	589.57	166.05

Horizontally: Evaluating effect of technique used on bone density in each interval.
Vertically: Evaluating effect of time on bone density in each group separately.

4. Discussion

The corals were selected for this research as they are more available and cheaper than many other grafting materials, at the same time, the differences between corals and these various grafting materials were not significant, *Velich et al., (2004)*. Corals also have no significant difference in bone density from autogenous bone grafts throughout time interval periods, *Block et al.,(1998)*.

Algipore group had demonstrated better bone density than control group during all follow up periods that was in agreement with *Sanchez et al, (2005)* who have found that the bony defects where demineralised freeze-dried bone graft (DFDBG) was used, either with or without platelet-rich plasma (PRP), did demonstrate slightly greater Bone Mineral Density (BMD) and Bone Mineral Content (BMC) than those left untreated. Digital radiography was used to measure bone density as it could detect minute changes in density *Jeffecoat (1993)*. Density measurement is used for providing an accurate measuring of gray scale values than the human eye can. The density of an image refers to its brightness. The maximum density value is 255, which corresponds to white. The minimum density value is zero, which corresponds to black. The different shades of gray have density values from 1 to 254, *Wenzel (1993)*. The bone density was significantly higher in laser group compared with control group at 6 weeks, 3 months and 6 months time intervals due to the ability of low intensity laser to increase bone density at the area of application, this was in agreement with *(Khadra et al, 2004 ; Lirani-Galvão et al, 2006; Miloro et al, 2007; Nissan et al, 2006 ; and Saito et al, 1997)* who suggested that laser therapy of low power density is effective on bone formation and the bone healing process by affecting calcium transport during new bone formation.

In Conclusion: Algipore (CORALS) can be a dependable bone substitute material for grafting bony defects in both jaws, Low Intensity Laser has also the ability to significantly increase bone density of empty cavities of jaws after enucleation of large cysts, so, it is preferred than Algipore specially with cases having infected lesions .

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