Original Article

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RADIOGRAPHIC EVALUATION OF BONE HEALING IN POST EXTRACTION SOCKETS FOLLOWING BONE GRAFTING USING AUTOGENOUS DENTIN AND BETA TRICALCIUM PHOSPHATE

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ABSTRACT:

Background and objectives: The present study was done to evaluate the bone density between two bone graft materials namely Autogenous Dentin and Beta tricalcium Phosphate bone graft in post extraction socket.

Materials and Method: A split mouth study was done in which twelve patients that required bilateral extraction of third molars. The post extraction defect were randomly assigned to receive either Autogenous Dentin or Beta tricalcium Phosphate along with placement of Collagen membrane (Perio Col). For the preparation of the Autogenous Dentin a specialized device called Smart Dentin Grinder(Kometa Bio) was used.

Radiographic parameters were recorded at baseline, third month, sixth month and twelfth month post operatively using Orthopantomograph and densitometric analysis was done using Adobe Photoshop Software Version 7

Results: Statistical evaluation was analysed by using Student t. The difference in the mean bone density between the two grafted sites were found to be 13.039 after radiographic analysis with a p value Of 0.030 ($p<0.05$).

Conclusion: The result obtained showed that the bone density of Autogenous Dentin was closer to that of the normal adjacent bone after twelfth month post operatively and so has better osteogenic properties.

Keywords: Autogenous Dentin, Beta tricalcium phosphate, Collagen membrane, Densitometric analysis.

INTRODUCTION

Extraction of tooth due to caries, trauma or advanced periodontal disease is a procedure that often results in immediate destruction and loss of alveolar bone and surrounding soft tissues. Post extraction, the portion of the jaw bone that anchors the teeth will not receive the necessary stimulation and it will begin to breakdown. This lead to alveolar bone resorption. [1,2]

Remodeling of the alveolar bone that occurs after tooth loss leads to diminished alveolar ridge dimensions in both the vertical and horizontal planes, upto 40% to 60% bone loss height and width, as early as 3 months.[2]

Post operative extraction tooth socket deformities can be prevented by a procedure called socket preservation. Socket preservation is an indispensable procedure needed to prevent bone loss after tooth extraction. It helps in the maintenance of the socket.[3]

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There are various graft materials used for socket preservation such as autograft, allografts and alloplastic materials, all of these materials show varying degree of success in bone healing after tooth extraction.[4]

Beta-tricalcium phosphate is one popular alternative to autogenous bone graft. It is a crystalline, synthetic ceramic substitute that has been widely used to repair bony defects because of its osteoconductive capacity and has no organic components, therefore no chances of antigenicity or allergic reactions. Moreover, no cytotoxic compounds are released during breakdown and resorption of this graft material.[5]

Evidence based study shows that auto tooth bone graft material supports excellent bone regeneration by its osteoinduction and osteoconduction capacity. It consist of 55% organic and 45% inorganic substances. In inorganic substances hydroxyapatite has the property of combining and dissociating calcium and phosphate as those of bone. Organic substances also contain bone morphogenetic protein and protein with osteoinduction capacity and type I collagen.[6]

This study was conducted for the evaluation of density of bone formation after the placement of Autogenous Dentin and Beta Tricalcium Phosphate radiographically using Gray scale analysis.

MATERIALS AND METHODS

This study is a prospective comparative study done in clinical setting.12 patients who require bilateral tooth extraction of mandible 3rd molar visiting the Department of Oral and Maxillofacial Surgery, Sri Siddhartha Dental College, Tumkur were included in the study. Patient's consent were taken, informed and described regarding post extraction socket grafting using Autogenous Dentin and Beta Tricalcium Phosphate. Duration of the study was 1 year.

The inclusion criteria were systemically healthy patients(ASA 1, 2), male and female patients between the age of 18 to 50 years, post extraction alveolar sockets that are free of acute infections, patients who are willing and able to provide informed consent and be available for multiple follow up visits.

The exclusion criteria were, subjects with systemic illness, subjects who are not willing to take part in the study, subjects with bleeding disorders, history of chemotherapy and radiotherapy in last 12 months, pregnant and lactating mother, subjects with known bone metabolic disorders, mandibular 3rd molar with deep dental caries, evidence of any cyst or tumor associated with the tooth.

In this study subjects were observed by an investigator at screening (0-15 days prior to surgery), at baseline (surgery/treatment) and at post-surgery (3, 6 and 12 months)

The following procedure were conducted during this study

Pre-op screening examination (1st visit)

- A signed written informed consent was obtained
- Medical and dental history and demographies (gender, age, ethnicity and history of tobacco used) related to each subject was recorded.
- Oral hygiene examination.
- Review oral hygiene instruction with subject.
- Radiographs and preoperative bone density analysis of the teeth requiring bone grafting should be obtained.

Treatment (2nd visit)

Clinical measurements performed by the examiner

- Atraumatic extraction
- Re-examination of the sockets to be grafted
- Grafting of the sockets
- Post-grafting radiographs were taken-Orthopantomograph radiograph

The following photographs before, during and following surgery were obtained

- Tooth before extraction.
- Preoperative radiographic bone density analysis.
- Grafting of the recipient site
- Postoperative radiographic bone density analysis.
- Area of surgery after primary closure with suture.

SURGICAL PROCEDURE

Creating the alveolar socket recipient site

The area selected for surgery was first anesthetised. Soft tissue flap reflection was done (an envelope flap) for adequate visualization of the alveolar socket, to allow easy management and placement of the graft material.

After the reflection, atraumatic tooth extractions were performed. The surrounding periosteum and periodontium was preserved as the vascular supply comes from the surrounding bony walls. The extraction sockets were debrided thoroughly and rinse with sterile saline.

Grafting procedure of extraction sites

FOR BETA TRICALCUIM PHOSPHATE: GROUP I(Fig 2)

It is available as 0.5cc sterile vial crystalline Beta Tricalcium Phosphate. After atraumatic extraction is done, any granulation tissue present in the socket was removed by surgical curettage. The socket will then filled with 0.5 - 1cc of crystalline Beta Tricalcium Phosphate. After the bone graft was placed in the socket, it was protected with resorbable membrane (Guided Bone Regeneration).

FOR AUTOGENOUS DENTIN (PROCESSING OF DENTIN): GROUP II(Fig 3,4 and 5)

The procedure consist of removal of any restoration, caries or debris of the extracted tooth by tungsten carbide burs. The cleaned tooth was then dried with air syringe. It was then grinded using Smart Dentin grinder. The dentin

particulate of 300-1200 micrometer was sieved through a special sorting system. The sorted particulate dentin was then immersed in basic alcohol sterile container consisting of 0.5M of Sodium Hydroxide and 30 percent alcohol for 10 minutes. It was then washed with sterile saline and then autoclaved. The particulate dentin would now be ready for placement. (Tissue engineering). After the bone graft was placed in the socket, it was protected with resorbable membrane (Guided Bone regeneration).

Panoramic radiograph was taken post operatively immediately.

POST-SURGICAL CARE

Patients were instructed to initiate chlorhexidine(0.12%) mouth rinse within the first 24 hours following grafting and to rinse thirty to sixty seconds twice daily for the first three weeks to maintain plaque control in the surgically treated area and to resume normal tooth brushing regimen in all areas except for the surgical site. Patients were prescribed oral Amoxycillin (500mg) , Metrogyl (400mg) and Zerodol SP for 5 days.

Post-surgical follow-up visits were done on third, sixth and twelfth months. Clinical examination of surgical site and Radiographical evaluation of the treated site were done(Fig 10, 11,12,13,14 and 15)

Radiographic analysis:

In this study, we observed the densitometric changes of two biomaterials on gray scale by Adobe Photoshop Software version 7 and compared each biomaterial filled socket to adjacent normal bone density every 3rd, 6th and 12th month post operatively. The entire radiograph were taken on same exposure rate, then converted to " jpg " format and transferred to Adobe Photoshop version 7.0, followed by calculation of measurement by single observer, who was blind to the experimental group, used histogram function to obtain mean density of the selected density of the selected area, in pixels. Bone density measurement will be done at the alveolar crest, furcation level and the apical region of the surgically removed third molars.

Statistical Analysis:

Data collected was entered in Microsoft Excel 2007 and analysed using Epi Info version 3.4.3. Descriptive statistics such as Mean and Standard deviation was calculated. Student t test was used to test the significance between Autogenous dentin and beta-tricalcium phosphate.

RESULTS:

The present study was conducted in Department of Oral and maxillofacial Surgery in coordination with Department of Oral Medicine and Radiology; Sri Siddhartha Dental College and Hospital, Tumkur.

The study was carried out in twelve patients aged between 22 and 27,comprising of 6 males and 6 females . Comparative radiographic evaluation was done for checking the density of bone formation in the extraction sockets in which bone grafting was done using Autogenous Dentin and Beta tricalcium Phosphate (Sybograf-T) which were covered with collagen membrane (Periocol). (Fig 4 to 13).The patients were followed up for a period of 12 months.

All the patient showed good compliance and the healing of the sockets were uneventful in both the treated group, without any signs of infection, which indicates the biocompatibility of graft materials.

RESULTS OF THE RADIOGRAPHIC PARAMETERS RECORDED

Gray scale analysis was done using the Adobe Photoshop Software version 7

There was no statistical significant difference in the bone density during the third and sixth month of the post operative follow up. During the twelfth month of the post operative follow up the significance difference between the two bone graft was observed.(Table 1 and 2)

The mean value obtained on gray scale for Beta Tricalcium Phosphate was 110.325 preoperatively, which was calculated from the adjacent bone of the particular tooth region, whereas post operatively mean value during the twelfth month follow up was 131.461, which was calculated particularly on the grafted region, with standard deviation of 9.881 and 10.250 respectively.(Table 3)

The preoperative mean value of Autogenous Dentin was 107.893 and postoperatively mean value after twelfth month of follow up was 115.990 with standard deviation of 8.660 and 8.148 respectively.(Table 3)

It was noticed that there was less difference in the bone density between preoperative value and post operative value for Autogenous Dentin (8.097) as compared to that of Beta Tricalcium Phosphate (21.136) (Table 3)

The statistical evaluation was analyzed by using Student t test , where Autogenous Dentin was found to be more superior than Beta Tricalcium Phosphate, with difference of 13.039 in the mean bone density and p-value showed more significance (0.030) during the Twelfth month.(Graph 4)

The result obtained for the bone density analysis in gray scale for preoperative and postoperative site showed that with Autogenous Dentin there was less bone density difference with that of the surrounding normal bone after 12 months and it was statistically significant than Beta Tricalcium Phosphate.

DISCUSSION

Extraction of tooth is one of the most commonly performed procedures in dentistry. There are different indications

for extraction of teeth. It may be necessary because of pain, infection, bone loss or fracture of the tooth. Tooth extraction whether due to caries, trauma or advanced periodontal disease is a traumatic procedure that will often lead to immediate destruction and loss of alveolar bone along with the surrounding soft tissues.[11,13,14]

It is known that alveolar bone plays an important role in providing support to the teeth, which are anchored to the bone by desmodontal fibres. Due to loss of anatomic, biologic and mechanical factors progressive alveolar bone resorption can occur after extraction, mechanical stimulation of alveolar bone during mastication is crucial in keeping the teeth and underlying bone healthy.4 So, if tooth extraction is necessary, it should be done in the most atraumatic way during the procedure so that bone preservation is possible.

Post extraction, the alveolar bone that anchors the teeth will no longer receive the necessary stimulation which will eventually lead to breakdown and bone resorption.

Alveolar bone remodeling that occurs after tooth extraction will lead to diminished alveolar ridge dimensions both in the vertical as well as horizontal planes up to 40% to 60% bone loss height and weight as early as 3 months.

The grafted extracted site had been reported with a loss of width <2mm and a loss of height <0.5mm as compared to the non-grafted extraction sites that had been reported with a loss of width from 2-6mm and ridge height of 1mm with great variations.[9]

Limited bone volume had been observed in the residual alveolar ridge generally in the residual alveolar ridge generally after tooth extraction due to ongoing progressive bone resorption. Healing events within post extraction socket reduce the dimensions of the socket over time. On an average, a reduction of about 50% in both horizontal and vertical directions had been observed over 12 months post extraction with two thirds of reduction occurring in the first 3 months.[10]

These deformities that occur after tooth removal can be prevented and repaired by a procedure called socket preservation. For socket preservation various techniques and materials had been used for extraction site grafting.

Various techniques have been used for ridge or socket preservation involving the use of bone grafts, barrier membranes and biological materials for better outcome.14 Various materials are used in modern dental and maxillofacial surgery for bone tissue substitution and reconstruction.

Biological mechanism of bone grafting are based osteoconduction, osteoinduction, osteogenesis, osteopromotion.[14]

All osteoplastic materials can be divided into four groups by origin as autogenous bone graft, allogenic bone graft,

xenogenic bone graft, alloplastic bone graft or synthetic bone substitutes.4 Among these various types of bone graft materials, autogenous bones are the most ideal. They are capable of osteogenesis, osteoinduction and osteoconduction. The main advantage is rapid healing time without immune rejection.[9]

Staring 1993, bone graft materials were developed using human teeth. In 2008, autogenous tooth bone graft material were developed from extracted teeth and prepared as a powder. It was then grafted to the operated site.[11]

Teeth are known as a composite of organic and inorganic components consisting of minerals of the calcium phosphate range, collagen and other organic elements.

The chemical composition of teeth and bone are very similar. Enamel is 96% inorganic ingredients, 4% organic ingredients and water. Dentin has a 65%:35% ratio, whereas cementum has the ratio of 45%-50%:50-55%. Finally, alveolar bone is made up of 65% inorganic ingredients and 35% organic ingredients.

Tooth dentin and cementum contain a number of bone growth factors including type I collagen and bone morphogenic protein (BMP). Type I collagen accounts for 90% and the remaining consist of noncollagenous proteins, biopolymer, lipid, citrate, lactate etc. non collagenous proteins include phosphophoryn, sialoprotein, glycoprotein, proteoglycan, BMP, etc. they can perform the role of promoting bone resorption and bone formation.

Dentin matrix has been proven to be osteoinductive and rich in BMP for a long time. 20% of dentin weight consist of organic component. It mostly consists of type I collagen. Moreover, it was proven to have BMP promoting cartilage and bone formation, differentiating undifferentiated mesenchymal stem cells into chondrocytes and osteogenic cells.

Dentin also contain noncollagenous protein such as osteocalcin, osteonectin, phosphoprotein and sialoprotein are known to be involved in bone calcification. Dentin matrix-derived BMP is not the same as bone matrix-derived BMP, but they are very similar.[8]

Currently most of the extracted teeth are considered a clinical waste so are simply discarded. According to several studies extracted teeth from patients that undergo a process of cleaning, grinding, demineralization and sterilization can be used as an effective graft to fill alveolar bone defects of the same patient.

A specialized grinder called Smart Dentin Grinder (FIG 3) was devised to grind and sort extracted teeth into a specific size dentin particulate. A chemical cleanser was then applied to process the dentin particulate into a bacteria free graft during 15-20 minute (FIG 10). This novel procedure is indicated mainly in cases when teeth are extracted because of periodontal reasons and partially or totally impacted teeth.

In a recent study conducted by Itzhak Binderman, Gideon Hallel, Casap Nardy, Avinoan Yaffe and Lari Sapoznikov during a period of 2 years, more than 100 procedures were performed using dentin bone graft, most of which for the purpose of preservation of alveolar bone. On X ray and biopsy of grafted sites a dense dentin-bone composite was found. No wound healing complications were observed.[13]

Autogenous bone is an ideal material for the preservation of socket defect as it promotes osteogenesis, osteointegration, osteoconduction and rapid healing. It also does not induce immune rejection. The disadvantage of autogenous bone as a grafting material include limited harvested volume and a second defect may be induced in the donor area.

In over to overcome these limitations, allogenic bone, xenogenic bone and synthetic bone have been used in clinical practice.6 Beta-Tricalcium phosphate is a synthetic bone graft and is also one of the popular alternative to autogenous bone. Beta tricalcium phosphate is known to be osteoconductive as it lacks growth factors and cellular components, it has no osteoinductive properties. Beta tricalcium phosphate has also been shown to be resorbable and simultaneously capable of supporting new bone formation.[7]

In a recent study by Shantipriya Reddy, Prasad MGS, Sanchuta Prasad, Nirjhar Bhowmick, Sravga L, Abis Amir and Krishnanad P after the placement of Beta tricalcium phosphate bone graft plug along with PRF membrane in post extraction socket there was as average mean loss of 7.3% and 4.9% in palatal/lingual and buccal vertical height respectively. There was an average mean reduction loss of 6.8% at the crest and an average loss of 10.2% at a level 6mm below the alveolar crest. So, they came with the conclusion that this bone graft can be used as a suitable material for extraction socket preservation.[11]

In this present study it was observed autogenous dentin and Beta tricalcium phosphate were well accepted within the extracted socket. A collagen membrane barrier was placed over the grated site, which helps in confining the grafted material within the extracted socket and is also resorbable, so secondary surgery is not needed. There were no incidence of allergic reaction and infection during the post operative follow up.

The bone density was radiographically evaluated using Adobe Photoshop software. The overall study duration was a period of one year. In the third and sixth month of the follow up bone formation were observed on both the groups but there were no significant difference in the bone density between the two groups. In the twelfth month of the follow up it was observed that the bone density of the autogenous dentin bone graft group were closer to that of the normal adjacent bone density.

The mean valve obtained after Gray scale analysis for Beta tricalcium phosphate graft was 110.325 preoperatively and 131.461 postoperatively. For Autogenous Dentin the mean value obtained was 107.893 preoperatively and 115.990 postoperatively (TABLE 3). The difference between the two bone grafts in density analysis was found to be statistically significant during the twelfth month follow up. The statistical analysis was done using student t test.(GRAPH 4)

In this study it was observed that autogenous dentin bone graft can be used as an ideal bone graft for socket preservation and also it is easily available for most of the grafting procedure.

CONCLUSION:

In this present study it was observed that Autogenous Dentin bone graft and Beta Tricalcium phosphate graft were well accepted on the post extraction grafted site. There were no infection and allergic reaction during the post operative follow up. Both the groups showed bony changes when analyzed radiographically using Gray Scale Analysis with Adobe Photoshop Software Version 7.

On the twelfth month of post operative follow up it was observed that the bone density of the post extraction site grafted with Autogenous dentin graft were closer to that of the normal adjacent bone.

Thus we can conclude that Autogenous Dentin bone graft can be used as an alternative bone graft for socket preservation as it is readily available and it also heals faster. Further study is needed with larger sample size in order to draw clinical and radiographic outcome of this study.

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FIGURE:

Fig 1:dentin grinder

FOR BETA TRICALCIUM PHOSPHATE GROUP

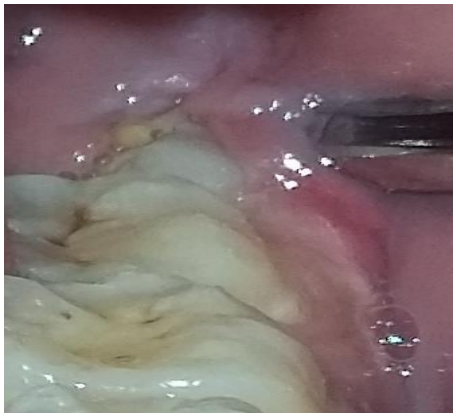


Fig 2: placement of sybograf with respect to 36

Fig 3: (beta tricalcium phosphate) in post extraction socket with respect to 36

Figure 4:Periocol (collagen membrane) placement over the grafted site

Figure 5: Placement of 3-0 silk suture on the extracted site

FOR AUTOGENOUS DENTIN GROUP

Figure 6: Preoprative photo with respect to 46

Figure 7: Grinding of extracted tooth for extraction of dentin

Figure 8:Application of dentin cleanser in the dentin powder

Figure 10: Periocol (collagen membrane) placement over the grafted site

Figure 9: placement of dentin autogenous bone graft in post extraction socket with respect to 46

Figure 11: Placement of 3-0 silk suture on the extracted site

RADIOGRAPHIC ANALYSIS OF BONE DENSITY

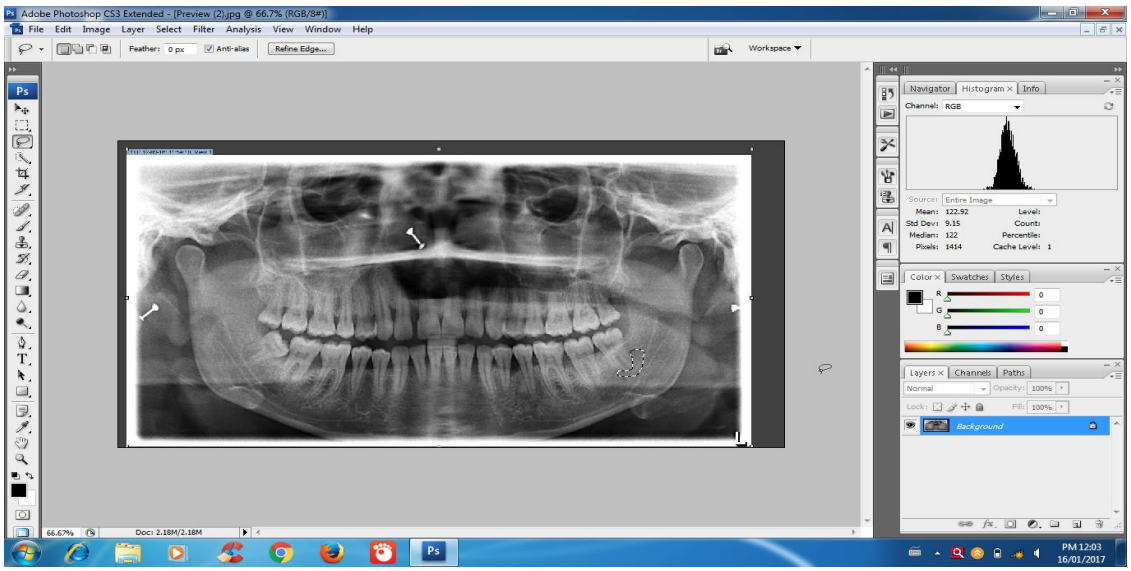


Fig12:preoperative radiographic bone density analysis wrt 36 (mean bone density-122.92)

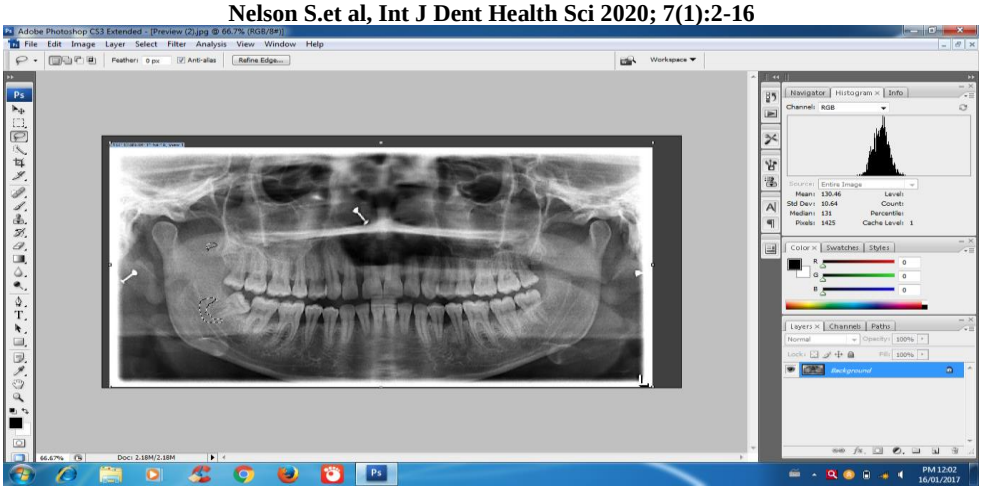


Fig 13:preoperative radiographic bone density analysis wrt 46 (mean bone density-130.46)

POST OPERATIVE AFTER 12 MONTHS

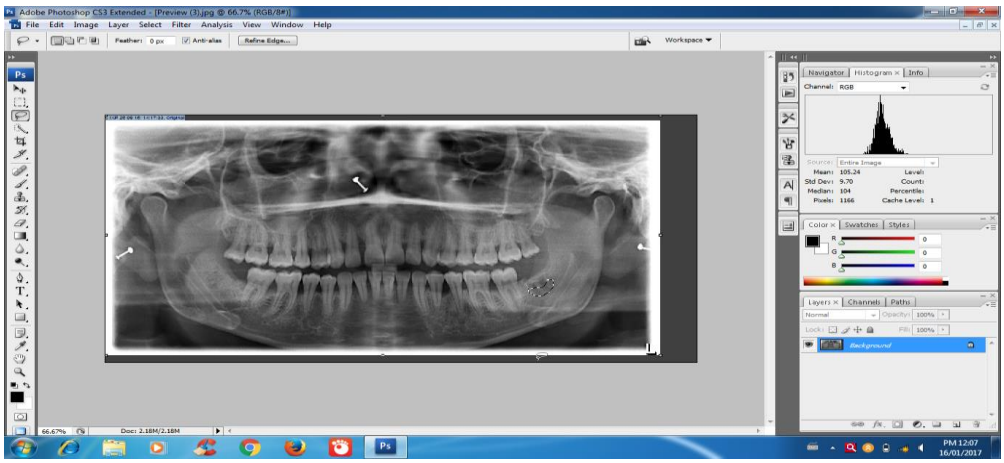


Fig 14:post operative radiographic bone density analysis wrt 36 After placement of autogenous dentin (mean bone density-105.24)

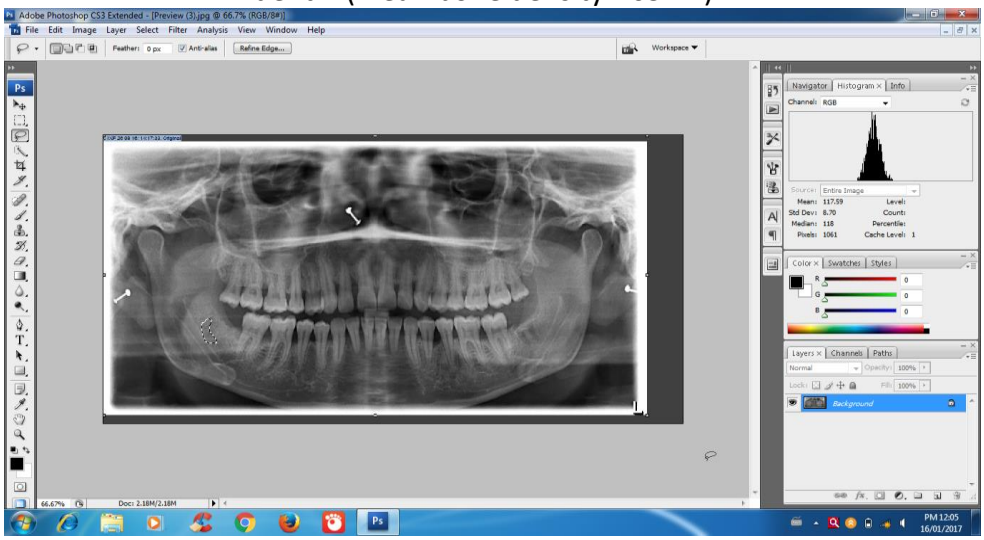


FIG 15:POST OPERATIVE RADIOGRAPHIC BONE DENSITY ANALYSIS WRT 46 AFTER PLACEMENT OF BETA TRICALCIUM PHOSPHATE (MEAN BONE DENSITY-117.59)

TABLES:

TABLE 1

POST OPERATIVE 12 MONTHS

N	Mean Age	Std. Deviation	Minimum	Maximum
12	25.00	1.414	22	27

	Gender		Total
	Male	Female	
Autogeneous dentin	6	6	12
	50.0%	50.0%	100.0%
Tricalcium Phospate	6	6	12
	50.0%	50.0%	100.0%
Total	12	12	24
	50.0%	50.0%	100.0%

Material = Autogeneous dentin

	N	Mean	SD	Mean Diff	SE of Diff.	t value*	P value	Correlation
Post Extraction Bone Density	12	115.990	8.148	8.097	2.501	3.237	***0.008***	0.470
Pre Extraction Bone Density	12	107.893	8.660					

*Student paired t test

Material = Tricalcium Phosphate

	N	Mean	SD	Mean Diff	SE of Diff.	t value*	P value	Correlation
Post Extraction Bone Density	12	131.461	10.250	21.136	5.031	4.2014.201	0.001	-0.499
Pre Extraction Bone Density	12	110.325	9.881					

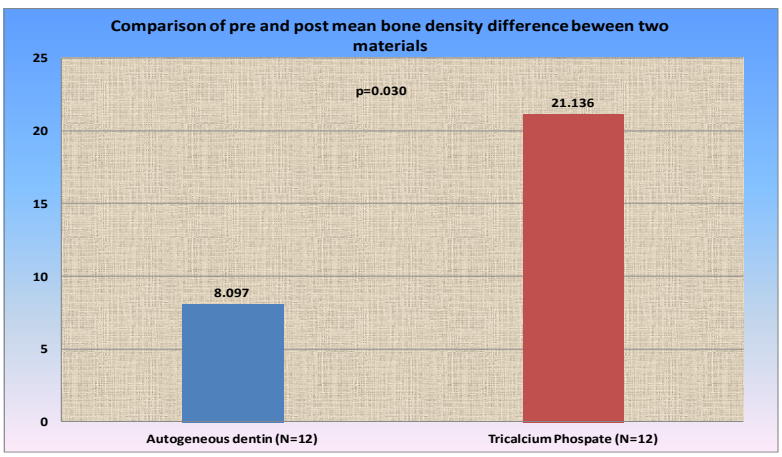
*Student paired t test

Difference (Pre-Post)

Material	N	Mean	SD	Mean Diff	SE of Diff.	t value*	P value
Autogeneous dentin	12	8.097	8.665	-13.039	5.619	-2.321	0.030
Tricalcium Phospate	12	21.136	17.429				

*Student t test

GRAPH:



PRE OPERATIVE AND POST OPERATIVE VALUE COMPARISION AFTER 12 MONTHS

GENDER MATERIAL

MALE-1 AUTOGENOUS DENTIN-1

FEMALE-2 BETA TRICALCIUM PHOSPHATE-2

SL NO	AGE	GENDER	MATERIAL	PREOP DENSITY	POSTOP DENSITY	DIFFERENCE
1	25	2	1	122.92	111.58	11.34
2	26	2	1	103.25	116.93	13.68
3	25	1	1	100.57	109.14	8.57
4	23	2	1	101.35	105.95	4.6
5	22	1	1	121.76	128.63	6.78
6	24	1	1	110.13	120.74	10.61
7	26	1	1	102.73	124.87	22.14
8	26	2	1	103.8	124.36	20.56
9	27	1	1	99.16	107.71	8.55
10	25	1	1	100.36	104.54	4.18
11	26	2	1	110.87	115.85	4.98
12	25	2	1	117.82	121.58	3.76
1	25	2	2	130.46	117.59	12.87
2	26	2	2	102.48	128.71	26.23
3	25	1	2	102.58	120.58	18
4	23	2	2	104.54	132.43	27.89
5	22	1	2	126.31	119.39	6.92
6	24	1	2	112.17	129.92	17.75
7	26	1	2	103.41	155.13	51.72
8	26	2	2	111.63	130.78	19.15
9	27	1	2	96.65	134.18	37.53
10	25	1	2	109.25	139.74	30.49
11	26	2	2	114.42	138.59	24.17
12	25	2	2	110	130.49	20.49