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EFFICACY OF THE B-TRICALCIUM PHOSPHATE IN THE STABILITY OF IMMEDIATE IMPLANT PLACEMENT- AN ORIGINAL RESEARCH

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ABSTRACT:

INTRODUCTION: *The long term prognostic, functional and aesthetic success of the conventional noninvasive and osseointegrated dental prosthesis depends on the presence of sufficient volume of healthy jaw bone.*

AIM: To evaluate the efficacy of the β-tricalcium phosphate (β-TCP) in the stability of immediate implant placement in mandibular first molar cases in twelve weeks period using radiographic aids.

MATERIAL & METHOD *Ten patient of 20-55yrs of age meeting the criteria for the study and reporting to oral and maxillofacial surgery OPD of Subharti Dental College with un-restorable mandibular first molar were included in this study.*

RESULT: *The mean densities for coronal buccal and lingual side, sagittal mesial and distal side, axial anterior, posterior, mesial and distal side were, 436.5 ± 374.7 & 381.2 ± 375.4 (p=0.006 & 0.004), 459 ± 493.7 & 490 ± 508.4 (p= 0.020 & 0.018), 639.4 ± 567, 381.8 ± 658.3, 198.2 ± 329.2 & 274.4 ± 765.1(p= 0.008, 0.115, 0.10& 0.30) respectively. The mean crestal bone loss on mesial and distal side were 0.60mm with SD of ± 0.6mm (p=0.02) and 0.4mm with SD of ±0.3mm (p=0.02) respectively.*

CONCLUSION: *β-TCP doesn't seem to be an ideal and highly beneficial bone filler around immediate implant placement, due to delayed osteoconduction and integration, poor handling and condensing property.*

Keywords: *- β-Tricalcium phosphate, Immediate implant, Osseo-integration*

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I. INTRODUCTION:

With increasing popularity of Implant dentistry, its longetivity has always been under focus which primarily depends on integration with the osseous tissues. Literature shows that long term prognostic, functional and aesthetic success of osseointegrated dental implants depends on the existence of adequate surrounding healthy jaw bone support. Factors like post-extraction healing and rehabilitation of the alveolar process plays a significant role in this process. [1-3]

A variety of preoperative and intraoperative measures have been taken by various researchers to conserve the alveolar bone. These are namely: good oral hygiene, minimal trauma during tooth extraction procedures so as to reduce the postoperative inflammation and its related bone loss, retain natural roots so as to maintain the alveolar process, use of prefabricated semi-analogous root form implants and lastly use of guided bone regeneration techniques. [4]

Immediate implant placement following tooth extraction has been thought as the best possible procedure as in this technique the natural healing process is triggered, no evidence of bone resorption has taken place so far, elimination of many surgical stages, and most important it has a positive emotional and psychological impact on patient as well .[5-7]

Though with above mentioned advantages, disadvantages like peri-implant bone defects due to inappropriateness of extraction socket and implant body can be observed. This can be prevented by using bone grafts which helps to fill the defect gap.[8] Several treatment modalities and materials are described with satisfactory results for dehiscences resulting from extraction or peri-implant pathology.[9,10]

Among the available materials used for pre-implant bone reconstruction, autologous bone is currently the gold standard because it is a source of osseous matrix, cells, and growth modulating molecules.[11] However, it requires the graft to be harvested at a distance from the surgical site, which makes the initial operation more complicated. To overcome the autograft limitations, many biomaterial have been proposed.[12]

Alloplastic calcium phosphate bone substitute, such as hydroxyapatite and tricalcium phosphate, have their composition resembling the inorganic phase of bone tissue.[13] On comparision Tricalcium phosphate has been shown to have superior resorption characteristics than hydroxyapatite.[14] Tricalcium phosphates are porous, resorbable, biocompatible materials, provoke little if any inflammatory response, permit the ingrowth of cells and vessels and have a direct connection with bony structure.[15,16] Beta-TCP crystal, in cement phase, is mixed with water, it requires longer time to turn into calcium-deficient hydroxyapatite, therefore, remaining in the tissue and favoring osteoconduction.[17]

As per our knowledge very few studies have been documented which studied the efficacy of the β-tricalcium phosphate in the stability of immediate implant placement in posterior jaws. Therefore, this prospective study was undertaken to evaluate the efficacy of Beta-TCP bone substitute as void filler in the cases of immediate implant in cases of immediate extraction sockets in mandibular first molar cases in six weeks and twelve weeks period using radiographic aids.

II. Material and methods:

Source and sample: A total of ten patients of 20-55yrs of age, reporting to oral and maxillofacial surgery OPD of Subharti Dental College with un-restorable mandibular first molar were included in this study. Patients with ASA-I including Lower first molar**,** with Periapical pathology (< 2mm) in diameter with clinically disease free overlying mucosa**,** with Upper first molar present and those with extraction socket having four wall defect were included in the study. Those patients which were more than 55 yrs of age, Medically compromised (uncontrolled diabetes, ischemic heart diseases, asthma & thyroid) , Pregnant ladies, Deep bite cases and with Periodontally compromised teeth (periodontitis) were excluded from our study. An informed consent was taken from all the patients and ethical clearance was obtained from the institutional ethical comette before the commencement of the study.

Technique: After taking verbal and written consent, patient's were advised for a IOPA and OPG to ascertain the, root form, length of the root of the involved tooth, its relation with inferior alveolar nerve and extent of the periapical pathology in relation with involved tooth if present. Preoperatively according to the dimensions obtained, the root form implant was chosen.

Under aseptic technique, using a No. 15 blade, a quadrangular mucoperiosteal flap was elevated. In case the involved tooth had straight roots, the tooth was extracted using molar extraction forceps. But if the tooth had dilacerated roots, then the odontectomy was performed to preserve the buccal bone. After proper curettage of the involved socket, copious irrigation was done to remove all remnants of the granulation tissue and necrotic tissue. The dimension of the socket were assessed and using a UNC – 15 probe. Then using the round bur, the pilot hole was marked in the inter-radicular bone of the involved socket. Followed with sequential osteotomy with sequential drill bits, using the sequential set of drill bits, the insertion path for root form implant was made. The insertion depth for the root form implant was made in 4mm beyond the length of root of extracted tooth, to achieve primary stability at the time of placement of root form implant. The root form implant was placed and secured in the extraction socket and space around the exposed area of implant and extraction socket was filled with β- Tricalcium phosphate bone cement (G-Bone). Primary closure was achieved with 3-0 Polyglycolic acid suture (Vicryl), in case the primary closure was not achieved, then the GTR membrane was adapted over extraction socket and closure with 3-0 Polyglycolic acid suture (Vicryl) was done over it. All patients were prescribed antibiotic and analgesics for a week.All patients were advised for IOPA, OPG and CBCT, to ascertain the position of root form implant, its relation with inferior alveolar nerve and, position and relation of bone cement with implant surface and extraction socket.

One week postoperative the patient was recalled for follow-up and surgical site was assessed for any suture dehiscence, implant exposure, bone cement extrusion and any surgical site inflammation. After 3 months the patient was recalled and IOPA, OPG and CBCT was performed, if there was CBCT finding of bone implant contact more than 50% and signs of osseointegration, then the secondary stability of the implant was assessed by reverse torque test and percussion test.

Data Collection : Preoperative intra oral periapical radiographs, intraoperative radiographs for parameters like horizontal dimension (mesiodistal dimension), vertical dimension lingual side (from cementoenamel junction), vertical dimension buccal side (from cementoenamel junction) and Postoperative

radiographs were recorded for all the cases studied. Sequential post-operative x-rays were taken Immediate, 6 weeks and 12 weeks in cases where applicable. Parameters studied included: Bone implant contact, Bone density around the implant, Bone regeneration at 6 weeks and Osteo-integration of implants at twelve weeks.

Clinical implant stability estimation Pre-operatively was done primarily by calculating Mesiodistal diameter of the site and Depth of the socket from cortical plates. Secondary stability (Post-operative 12 weeks) was evaluated by Reverse torque test and Percussion test.

STATISTICAL ANALYSIS: All the observations were tabulated and summarized using descriptive statistics (N, mean, median, standard deviation, minimum, and maximum). All analyses were performed using SPSS version 21 (IBM Corp, Armonk, NY).

III. RESULTS:

This retrospective study included a total of ten patients of 20-55yrs of age range. Our results show that there was minimal bone formation around the implants. The mean coronal buccal and lingual densities were 436.5 ± 374.7 & 381.2 ± 375.4 (p=0.006 & 0.004) respectively, the mean sagittal mesial and distal density was 459 ± 493.7 & 490 ± 508.4 (p= 0.020 & 0.018) respectively (table 1, graph 1). The mean axial density on anterior, posterior, mesial and distal side were, 639.4 ± 567, 381.8 ± 658.3, 198.2 ± 329.2 & 274.4 ± 765.1(p= 0.008, 0.115,0.10 & 0.30) respectively. The mean basal bone density noted in our study was 187.1 ± 262.9. (table 2, graph 2)

TABLE 1: OBSERVATIONS OF MEAN CORONAL AND MEAN SAGGITAL DENSITY OD BONE AT THE END OF 12 WEEKS POSTOPERATIVELY

SN	mean coronal buccal	mean coronal lingual	mean saggital mesial	mean saggital distal
1	514.3	1162.3	-60.2	-534.1
2	-197.4	162.2	-20	129.9
3	46.2	299.1	-325.3	151.2
4	576.2	102.9	576.2	176.5
5	827.4	659.7	1187.7	773.3
6	950.26	522.6	1045.8	1118
7	403	440.6	764.6	827
8	157.1	230.5	212.9	291.4
9	934.4	1132.1	951.6	1181

10	153.53	99.9	265.2	786.4
MEAN	**436.5**	**481.2**	**459.9**	**490.1**
SD	**374.7**	**375.4**	**493.7**	**508.4**

GRAPH 1: GRAPH SHOWING MEAN CORONAL AND MEAN SAGGITAL DENSITY OF BONE AT THE END OF 12 WEEKS POSTOPERATIVELY

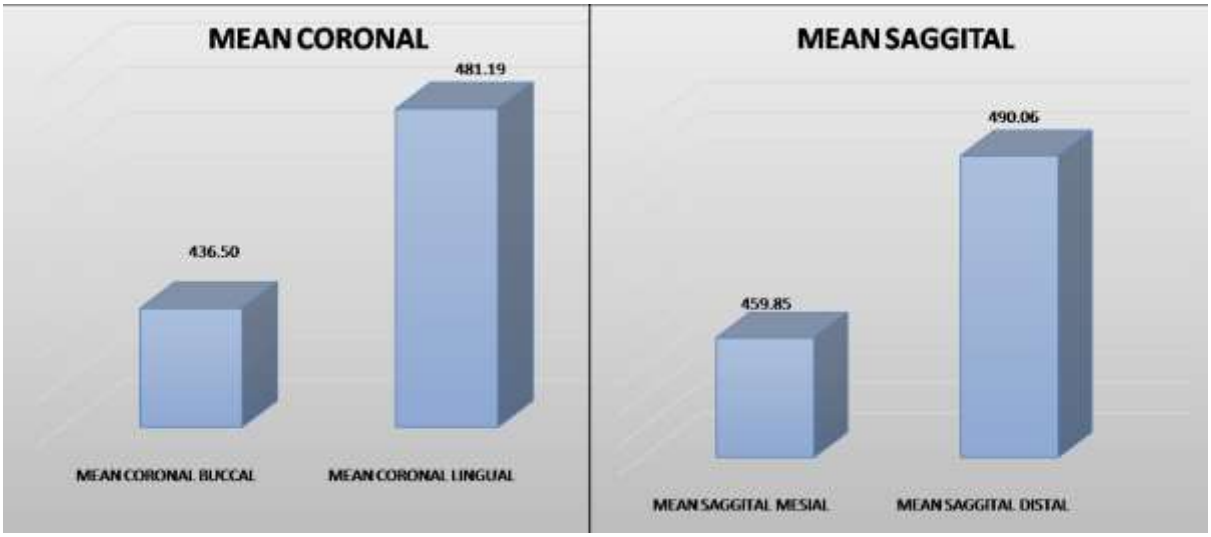

TABLE 2: OBSERVATIONS OF MEAN AXIAL DENSITY OF BONE AT THE END OF 12 WEEKS POSTOPERATIVELY.

SN	axial density (anterior)	axial density (posterior)	axial density (mesial)	axial density (distal)
1	1228.1	1175.1	-223	-453.6
2	-206.5	320.6	-258.1	-406.4
3	32.7	208.9	-82.4	-391.4
4	1145.3	1141.3	801.7	-210.9
5	46.62	-1148.6	575	1499
6	1328.9	544	514.4	-304.2
7	547.9	828.2	166.2	153.7

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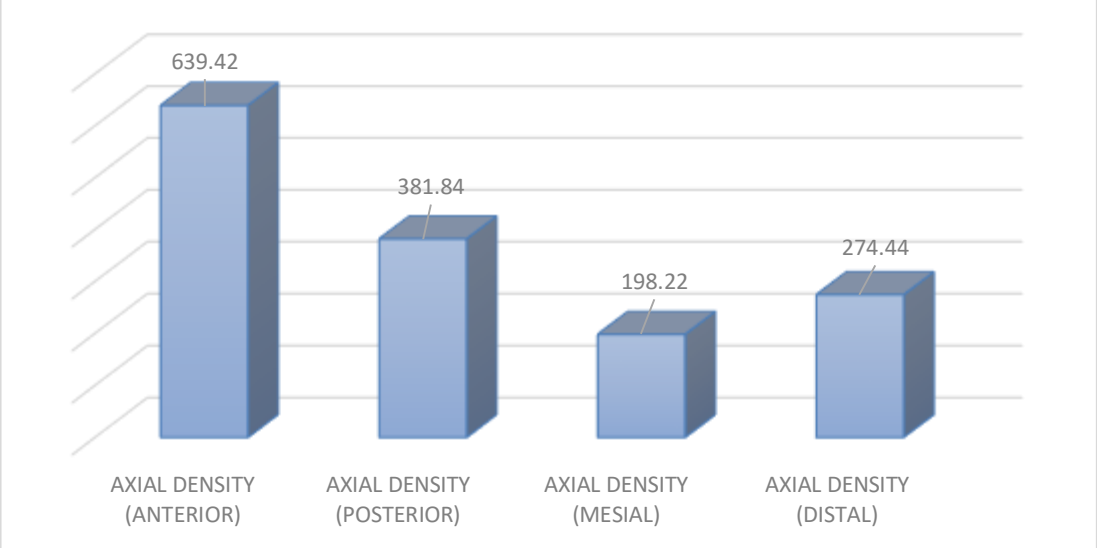
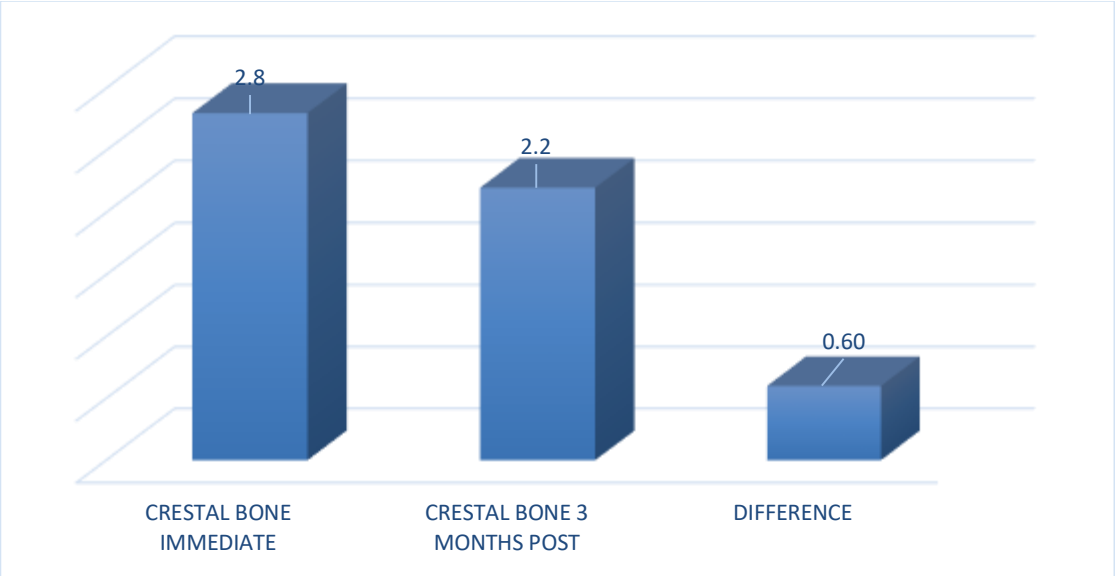
8	446.9	-124.4	102.3	311.3
9	1415.9	73.2	153.7	1683.1
10	408.4	800.1	232.4	863.8
MEAN	**639.4**	**381.8**	**198.2**	**274.4**
SD	**567.0**	**658.3**	**329.2**	**765.1**

GRAPH 2: GRAPH SHOWING MEAN AXIAL DENSITY OF BONE AT THE END OF 12 WEEKS POSTOPERATIVELY.

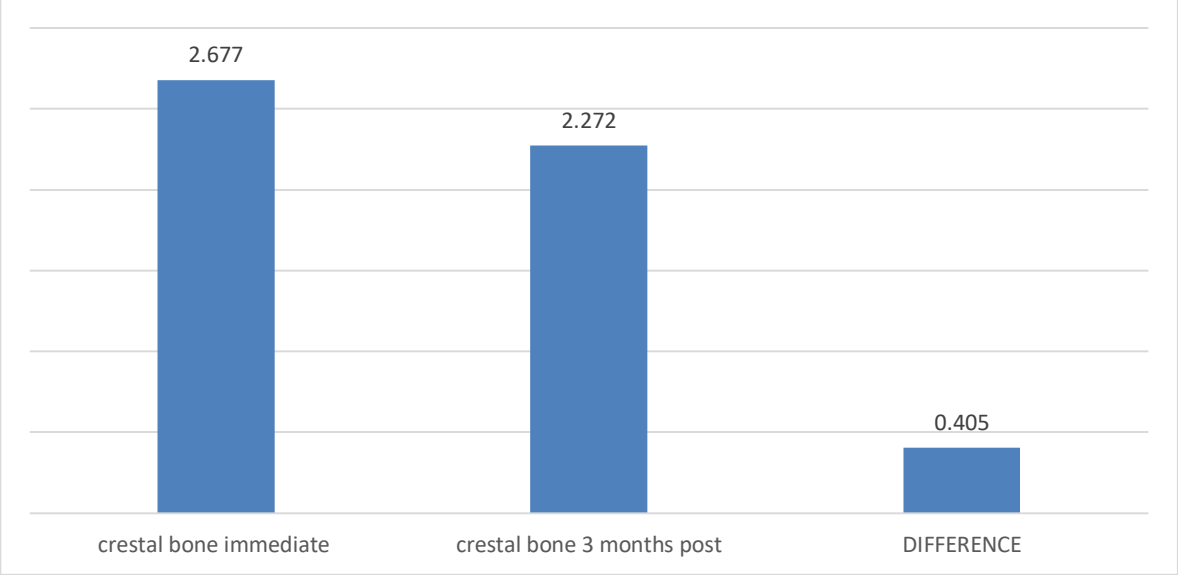


In the present study, the mean mesial crestal bone loss was recorted as 0.60mm with SD of ± 0.6mm (p=0.02) and mean distal crestal bone loss was 0.4mm with SD of ±0.3mm (p=0.02). (Graph 3 &4). On follow up of 12 months, it was seen that crestal bone had gained in height by 0.25mm on mesial side and there was loss of 0.48mm on distal side, from the original recorded crestal height.

GRAPH 3: MEAN MESIAL CREASTAL BONE LOSS OBSERVED IN THE STUDY



GRAPH 4: MEAN DISTAL CREASTAL BONE LOSS OBSERVED IN THE STUDY



The mean distance from crest to implant-abutment interface was found to be 2.2mm±1.7mm and 2.27±1.64mm on mesial and distal side proximal surface.

Evaluating for implant stability by using both reverse torque pressure of 20NCm and with precursion methods in all 10 cases, it was observed that there was no sign of mobility and a clear crystal sound was also appreciated by two observers in all 10 patients which showed secondary stability of the implants.

Further as all the surgical site were post-operatively covered with Coe-pack, The epithelial closure of the mucoperiosteal flap was seen in 15 day's time, without any dehiscence in 8 out 10 cases.

After 3 months, in two of ten patients, there was dehiscence of the soft tissue over the surgical site, with subsequent graft extrusionwas noticed. The graft material was mobile and had not integrated with the

adjacent bone. The excess graft material was removed and primary closure was done after re-freshening of the margins of the mucoperiosteal flap.

Also the radiological analysis of the implant and peri-implant areas showed that there were no signs of peri-implantitis or progression of peri-apical pathologies.

IV. DISCUSSION:

This study presents clinical, radiographic observations of immediate extraction and immediate implant healing at 10 sites treated with the β-tricalcium phosphate observed for a period of 3 months. There have been several attempts to prevent post extraction atrophy of the alveolar ridge so as to maintain regenerate (augment) the alveolar process when they were seriously diminished due to periodontal or other diseases before extraction of the affected tooth.

Our results show that at the end of 12 weeks there was minimal bone formation (mean coronal, saggital and axial densities) observed. It could be suggested that mean change in density around the implant was suggestive of gradual formation of bone around the implant fixture. Increased density around the implant fixture may mean change of type IV (very thin cortical bone with low density trabecular bone of poor strength) bone into type III (thin cortical bone with dense trabecular bone of good strength) bone due to the osteoconductive property of β-TCP. Barone A et al, also reported that the bone was significantly more mineralized around immediately loaded implants than unloaded ones.[18]

On contrary in a stusy done by Boix D et al β-TCP significantly increased bone regeneration around immediately placed implants.[12] They observed considerable bone formation observed in all dimensions over a period of 8 months.

Similarly in a long term follow-up study by Kokovic and Todorovic, also showed that the use of β-TCP coated with PLGA root analogue after tooth extraction enables satisfactory bone architecture for consequent implant treatment at 52 weeks of followup.[19] Brkovic et al demonstrated sufficient amountsof vital bone and socket morphology were present after use of the β-tricalcium phosphate to support dentalimplant placement after the 9-month healing period.[20]

This variability in our results could be explained on the basis that 3 months of follow-up in our study is too little of time for achieving good quality of bone around the implant, may be due to the slow osteoconductive properties and poor osteo-integration property of β-TCP, when it comes in contact with body fluids. A minimum 6-12 moths are needed for a significant bone to form around the implant fixture.

Further in our study, we found out the mean mesial crestal bone loss to be 0.60mm and mean distal crestal bone loss was 0.4mm, which is a significant finding. In a short term follow-up of these patients, the mean crestal bone loss is near about the annual loss of crestal bone seen in the normal healing extraction socket (.8-1mm). But on follow up of 12 months, it was seen that crestal bone had gained in height by 0.25mm on mesial side and there was loss of 0.48mm on distal side, from the original recorded crestal height.

Adell et al found that the mean bone loss for Branemark implants was 1.5mm while Cox and Zarb showed a mean bone loss of 1.6mm from the surgical placement of the end of the first year.[21,22] In the study

done by Cavallaro, the mean mesial and distal bone changes at the 6 months interval were 0.75 and 0.79mm, respectively. At 1 year, the corresponding mesial and distal values were 0.96mm and 0.83mm.[23,24] Albrektsson et al considered an implant successful if it didn't demonstrate progressive bone loss greater than 0.2mm annually after the first year of implant placement.[25]

In our study we placed the implants 5 mm beyond the original socket depth to achieve primary stability for each implant as the bone apical to the site of implant fixture was denser than the surrounding bone. The mean distance from crest to implant-abutment interface were 2.2mm±1.7mm and 2.27±1.64mm on mesial and distal side proximal surface. Cavallaro et al reported that after 12 months of healing, and upto the 24 and 36 month time frames, the implant demonstrated minimal alterations of proximal bone levels in healed ridges or extraction sockets.[26]

In our study on evaluating for implant stability in all 10 cases studied, there was no sign of mobility, showing secondary stability of the implants, on application of 20NCm of pressure. On percussion also a clear crystal sound could be appreciated by two observers in all 10 patients indicating secondary stability of implants. Sullivan et al also reported similar results which were in accordance to our study. It was further suggested that reverse torque test is, therefore, a reliable diagnostic method for verification of osseointegration.[27]

In a study conducted by Johansson and Albrektsson, a reverse torque was applied to remove implants placed in the tibia of rabbits 1, 3, 6, and 12 months post-surgery. Reverse torque value and histologic evaluation showed that greater bone implant contact could be achieved with a longer healing time.[28]

Later in our study after 3 months, two of ten patients showed dehiscence of the soft tissue over the surgical site, with subsequent noticable graft extrusion. The graft material was mobile and had not integrated with the adjacent bone. The excess graft material was removed and primary closure was done after re-freshening of the margins of the mucoperiosteal flap.

Arisan V et al did a study on potential of the calcium phosphate cement as graft material around peri-implant dehiscence defects in dog model. They observed that after 12 weeks of healing, the cement didn't degrade completely and wasn't replaced with new bone completely. They concluded that the injectable calcium phosphate cement regenerated bone supports implant-to-bone contact.[10]

Galbraith PJ and Chew FS reported that there is an important site of weakness in the bone at the site of screw insertion, there is initial reduction of bone mass surrounding the insertion hole for 18 weeks, as the β-TCP has slow osteoinductive property, thus in the meantime, there are chances of graft material extrusion[122]. The resorption of tricalcium phosphate is approximately 10% per month with complete resorption at 6- 24 months.[29]

Thus overall, the radiological analysis of the implant and peri-implant areas showed that there were no signs of peri-implantitis or progression of peri-apical pathologies. There was slight increase in vertical dimension from the crest to apex of the implant. The graft material could be seen migrating from the surgical site apically, or mesially or distally. The apical density increased in most of the cases when assessed on the OPG.

V. Conclusion:

Within the limits of the present study, it was concluded that, β-TCP doesn't seem to be an ideal and highly beneficial bone filler around immediate implant placement, due to delayed osteoconduction and integration, poor handling and condensing property. Although 3 months follow-up is too short to assess the clinical benefits of β-TCP in immediate implant placement as a defect filler around the implant fixture to promote good osseo-integration, so larger sample size and longer follow-up are needed.

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