Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2020;10:4:332-340.

Treatment Options in Periapical Lesions of Maxillofacial Region: A Comparative Study

Abhishek Kumar[1*] Ajay Kumar Singh[2] Neha Singh[3]

[1]Senior Lecturer, Department of Oral and Maxillofacial Surgery, Buddha Institute of Dental Sciences and Hospital, Patna, Bihar, India.
[2]Professor, Department of Oral and Maxillofacial Surgery, Buddha Institute of Dental Sciences and Hospital, Patna, Bihar, India.
[3]Senior Resident, Department of Oral and Maxillofacial Surgery, IMS, BHU, Varanasi, UP, India.

ABSTRACT

Background: Regeneration and/or reconstruction of bony skeleton is important to restore the normal function of the craniofacial unit. The maxillofacial region is a complex tissue, consisting of bone, cartilage, soft tissue, nerves, and blood vessels. Calcium phosphate ceramics like hydroxyapatite and β -tricalcium phosphate (β -TCP) possess mineral composition that closely resembles that of bone. They can be good bone substitutes due to their excellent biocompatibility. Biphasic calcium phosphate is a bone substitute which is a mixture of hydroxyapatite and β -tricalcium phosphate in fixed ratios. Studies have demonstrated the osteoconductive potential of this composition with clinical use as a bone substitute in periapical surgeries. The development of biphasic calcium phosphate ceramic made it possible to control the resorbability of tricalcium phosphate and at the same time maintain the osteoconductive potential of hydroxyapatite.

Keywords: Periapical, hydroxyapatite, tricalcium phosphate.

INTRODUCTION

The maxillofacial region is a complex tissue, consisting of bone, cartilage, soft tissue, nerves, and blood vessels. Conditions such as cancer surgeries, trauma, congenital malformations, and progressively deforming skeletal diseases, can damage the maxillofacial structures, leading to deformity.[1] The only solution to these deformities is its reconstruction. Regeneration and/or reconstruction of bony skeleton is important to restore the normal function of the craniofacial unit. The optimal bone construct for repair should be biodegradable, able to replicate the lost structure and completely restore its function, and easily replaceable through the body's physiologic processes, harmless for the patients, and reliable in defects.[2] The procedures used for reconstruction of maxillofacial bone are mostly based on autologous, allogenic, or alloplastic grafting sources with variable clinical outcomes and morbidities. These procedures rely on the ability to recruit local stem cells or committed progenitor cells that would regenerate the defect.Allograft is defined as a tissue graft between individuals of the same species (i.e., humans) but of non-identical genetic composition. Xenograft is defined as a tissue graft between two different species (i.e., bone of bovine origin). Alloplast usually includes any synthetically derived graft material not coming from animal or human origin. This usually includes hydroxyapatite, β-TCP, or any formulation thereof. Each of the bone graft materials is usually developed with a specific purpose or advantage in mind. The main purpose of using these graft materials is usually to avoid a secondary surgery for harvesting autogenous bone.[3] Intensive investigative research has shown calcium phosphate ceramic biomaterials to be safe and effective for a variety of restorative and preservative clinical applications. Two forms of calcium phosphate ceramics, hydroxyapatite (HA) and tricalcium phosphate (TCP), have received attention. They possess a mineral composition very close to that of normal bone. Their biocompatibility

Received: Aug. 7, 2020**: Accepted**: Sept. 8, 2020
*Correspondence **Dr. Abhishek Kumar.**
Department of Oral and Maxillofacial Surgery, Buddha Institute of Dental Sciences and Hospital, Patna, Bihar, India.
Email: Not Disclosed

pISSN 2278-0076
eISSN 2321-9270

makes them successful bone substitutes. HA is the natural mineral component of vertebrate hard tissue, comprising 60% to 70% of bone and 98% dental enamel.[4] In appropriate synthetic form, HA is generally observed to be non-bioresorbable and therefore accountable for long-term restorative and preservative clinical procedures. TCP is clinically similar to HA but is not a natural component of bone. It is partially bioresorbable and is often considered desirable for repair of morphological site. Calcium phosphate biomaterials are devoid of local or systemic toxicity, do not elicit inflammatory or foreign body responses and can become functionally integrated with natural bone with no fibrous tissue encapsulation.[5]Calcium phosphate biomaterial provides a physical matrix suitable for deposition of new bone and can display growth-guiding properties causing bone to extend its growth into areas that otherwise it would not occupy.It also has the ability to maintain bone bulk in areas where bone resorption formally takes place. HA implants have been used successfully to prevent post-extraction alveolar ridge resorption. Biphasic calcium phosphate ceramics consist of both β-tricalcium phosphate and hydroxyapatite. The alliance of these two components allows bioactivity to be controlled through a combination of HA and β-TCP properties.[6] Previous studies have shown that biphasic calcium phosphate (BCP) has osteoconductive potential. The development of biphasic calcium phosphate ceramic made it possible to control the resorbability of tricalcium phosphate and at the same time maintain the osteoconductive potential of hydroxyapatite.[7,8]

The aim of the present study was to compare simple enucleation or curettage versus concomitant hydroxyapatite and beta tri calcium phosphate granules placement in periapical lesions of maxilla and mandible of size 1 to 2cm.In a continuous search of best reconstruction material researchers are busy finding new approaches to benefit our patients and minimise possible complications.

MATERIALS AND METHODS

The study comprised 20 patients with maxillofacial bony defects of 1-2 cm size, who visited our centre from July 2017 to January 2019.It was a prospective randomized experimental study. Detailed medical history of all enrolled patients was recorded on a set proforma designed for the study. Patients were diagnosed on the basis of clinical as well as radiographic examination. Routine investigations were done. The patients were enrolled irrespective of age, sex, caste and creed, if their maxillofacial bone defects (periapical pathology) was 1-2 cm in size.The patients were excluded if they had bone diseases (e.g. Pagets disease, Cherubism,) ,underwent irradiation and had uncontrolled diabetes,Any known metabolic disease , pediatric or geriatric patients were too excluded.

Sample size: 20 patients were included and were randomly divided into two groups.This study comprised of two groups:

- **Group I :** 10 Patients where only Enucleation or Curettage was done.
- **Group II:**10 Patients where after Eucleation or Curettage, hydroxyapatite(60%) and beta tricalcium phosphate(40%) granules were placed.

Method:

After performing enucleation/curettage and apicoectomy the defect was primarily closed or filled with the graft granules. Clinical & radiographic assessment was done at day 7, 2nd week, first month and sixth month.

Armamentarium used for surgery:

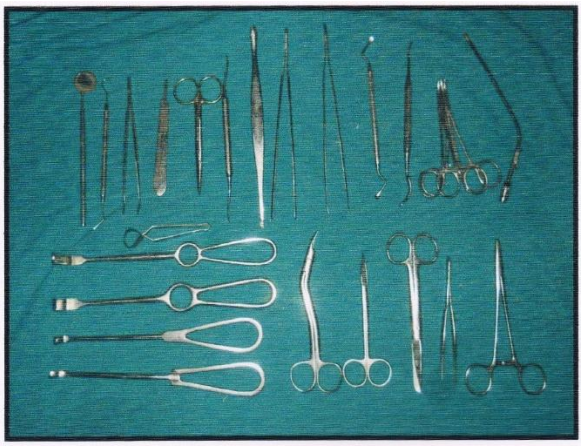


Fig 1: Instruments.

Surgical Technique

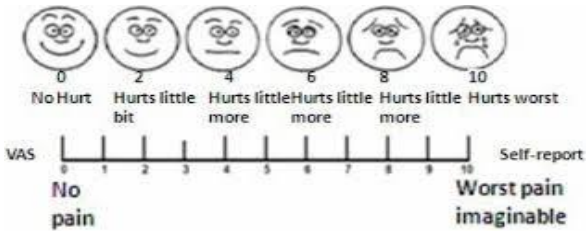
Anaesthesia:

Patients were operated under Local Anesthesia. Patient was seated on dental chair. Standard part preparation and surgical draping was done to ensure sterile field.

A crevicular incision was made through the mucosa in the gingival crevice along with two releasing vertical incisions extending into the mucogingival junction, thus trapezoidal flap was raised and the cystic lesion was exposed. Enucleation and curettage was done to remove the lesion *in toto*. Apicoectomy was performed and bony defect was thoroughly irrigated with betadine solution. Closure of the flap was done with with 3-0 black silk suture.The patient was advised soft diet for a week followed by normal diet, 0.2% chlorhexidine rinses., antibiotics and anti-inflammatory drugs for one week postoperatively.

Assessment of the patients was done under following parameters :

1) **Pain –** Visual analogue scale (0 – 10).



2) **Swelling-Technique-(Objective assessment) Laskin and Amin (1983) and Gallardo *et al.* (1990).**

The swelling was measured as the linear distance between corner of mouth and the lobe of ear, and the linear distance between outer canthus and the angle of mandible (gonion). Swelling measurements were done preoperatively and postoperatively at each follow up of (1st week, 2nd week, 1st month, and 6th month).

Swelling

- 3*3 cm: 3
- 2*2: 2
- 1*1: 1
- Absent: 0

3) Tooth Mobility – Present / Absent

- Grade III:
- Grade II:
- Grade I: Absent

4) Lymph Nodes

- Palpable
- Not palpable

5) Pus Discharge

- Present
- Absent

Follow up :

At 1st week, 2nd week, 4th week, and 24th week.

Radiographic Evaluation :

OPG and CBCT were done preoperatively and then at 2 weeks, 4th week and 24th week.

Radiographic (percentage bone fill)-

- Total number of small squares covering the defect (preoperative) = A
- Total number of small squares covering the defect (postoperative follow op) = B
- Percentage bone fill = $\frac{A-B}{A} \times 100$

Complications:

Postoperative complications considered were

- Gape
- Discharge
- Extrusion of graft
- Nerve Injury

RESULTS

Table 1: Age distribution between the groups.

Groups	Group I	Group II
Age in years (Mean ± SD)	30.20±11.84	25.30±9.61

Unpaired t-test : p= 0.32

Table-1 & Fig.1 shows the age distribution between the groups. There was no significant (p>0.05) difference in the age between Group I (30.20±11.84) and Group II (25.30±9.61).

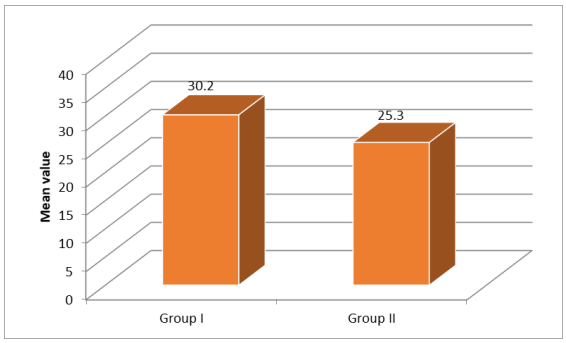


Fig 1: Age distribution between the groups.

Table 2: Gender distribution between the groups.

Gender	Group I (n=10)		Group II (n=10)	
	No.	%	No.	%
Male	5	50.0	3	30.0
Female	5	50.0	7	70.0

p=0.36 (Chi-square test)

Table-2 & Fig.2 shows the age distribution between the groups. There was no significant (p>0.05) difference in the gender between Group I and Group II.

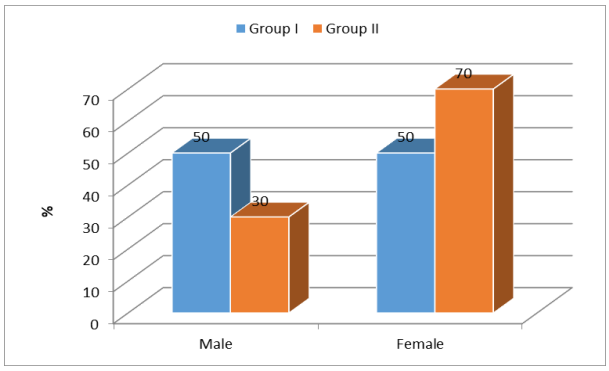


Fig 2: Gender distribution between the groups

Table 3: Comparison of VAS pain score between the groups at different time intervals

Time intervals	Group I	Group II	p-value[1]
Pre-op	7.70±0.48	7.60±0.51	0.15
Day 7	4.30±1.25	3.90±0.87	0.39
Week 2	1.10±0.31	1.00±0.00	NA
Week 4	1.00±0.00	1.00±0.00	NA
Week 24	1.00±0.00	1.00±0.00	NA

Unpaired t-test, NA-Not applicable

Table-3 & Fig. 3 shows the comparison of VAS between the groups at time intervals. There was no significant (p>0.05) difference in the VAS at pre-op and Day 7 between the groups and became similar after Week 2.

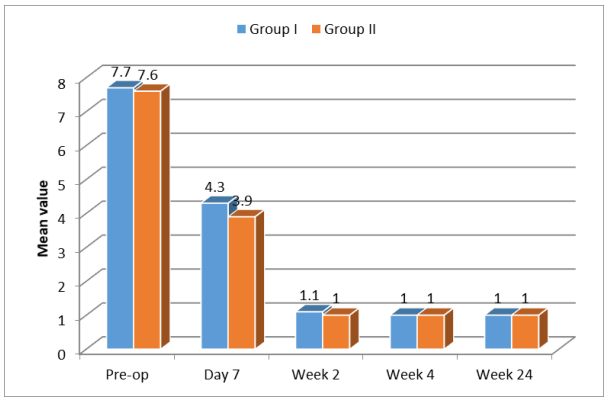


Fig 3: Comparison of VAS pain score between the groups at different time intervals

Table 4: Comparison of swelling between the groups at different time intervals .

Time intervals	Group I	Group II	p-value[1]
Pre-op	1.90±0.87	1.90±0.73	1.00
Day 7	0.60±0.51	0.70±0.48	0.66
Week 2	0.00±0.00	0.00±0.00	NA
Week 4	0.00±0.00	0.00±0.00	NA
Week 24	0.00±0.00	0.00±0.00	NA

Unpaired t-test, NA-Not applicable

Table-4 & Fig. 4 shows the comparison of swelling between the groups at time intervals. There was no significant (p>0.05) difference in the VAS at pre-op and Day 7 between the groups and became nil after Day 7.

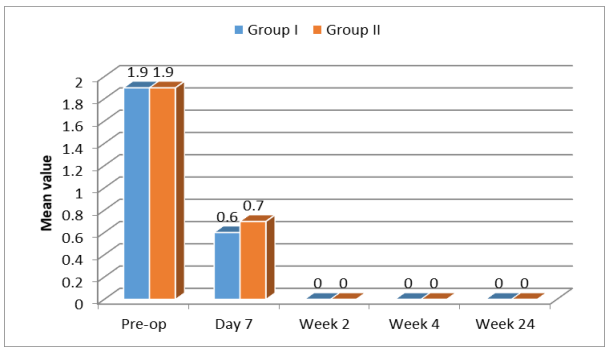


Fig 4: Comparison of swelling between the groups at different time intervals.

Table 5: Comparison of tooth mobility (in which apicectomy is done) between the groups at different time intervals.

Time intervals	Group I		Group II		p-value[1]
	No.	%	No.	%	1.00
Pre-op					
Absent	10	100.0	10	100.0	NA
Day 7					
Absent	5	50.0	6	60.0	0.65
Grade I	5	50.0	4	40.0	
Week 2					
Absent	10	100.0	10	100.0	NA
Week 4					
Absent	10	100.0	10	100.0	NA
Week 24					
Absent	10	100.0	10	100.0	NA

Chi-sqaure test, NA-Not applicable

Table-5 & Fig. 5 shows the comparison of tooth mobility between the groups at time intervals. The tooth mobility was absent in both the groups at pre-op. The grade I tooth mobility was observed in 50% patients of Group I and in 40% patients of Group II, however, the difference was found to be statistically insignificant (p>0.05). The tooth mobility became absent after Day 7 in both the groups.

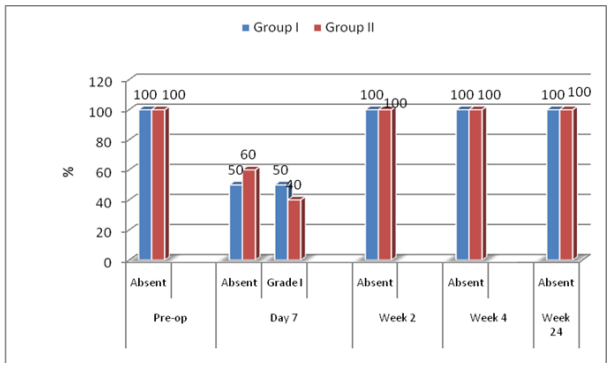


Fig. 5: Comparison of tooth mobility (in which apicectomy is done) between the groups at different time intervals

Table 6: Comparison of lymph nodes between the groups at different time intervals

Time intervals	Group I		Group II		p-value[1]
	No.	%	No.	%	
Pre-op					
Palpable	3	30.0	2	20.0	0.60
Not palpable	7	70.0	8	80.0	
Day 7					
Palpable	3	30.0	2	20.0	0.60
Not palpable	7	70.0	8	80.0	
Week 2					
Palpable	0	0.0	0	0.0	NA
Not palpable	10	100.0	10	100.0	
Week 4					
Palpable	0	0.0	0	0.0	NA
Not palpable	10	100.0	10	100.0	
Week 24					
Palpable	0	0.0	0	0.0	NA
Not palpable	10	100.0	10	100.0	

Chi-sqaure test, NA-Not applicable

Table-6 & Fig. 6 shows the comparison of the lymph nodes between the groups at time intervals. The palpable lymph node was observed in 30% patients of Group I and in 20% of Group II at pre-op which remained at Day 7, however, the difference was statistically not significant (p>0.05). The palpable lymph node became nil in both the groups after Day 7.

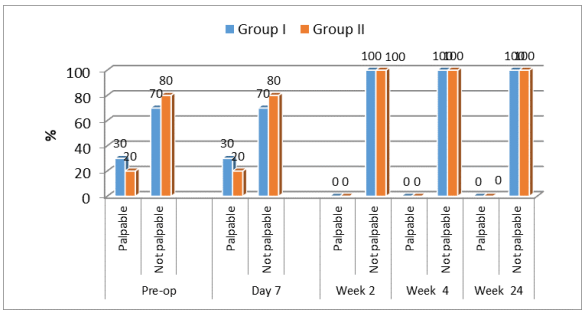


Fig 6: Comparison of lymph nodes between the groups at different time intervals

Table 7: Comparison of pus discharge between the groups at different time intervals

Time intervals	Group I		Group II		p-value[1]
	No.	%	No.	%	1.00
Pre-op					
Present	3	30.0	2	20.0	0.60
Absent	7	70.0	8	80.0	
Day 7					
Present	3	30.0	2	20.0	0.60
Absent	7	70.0	8	80.0	
Week 2					
Present	0	0.0	0	0.0	NA
Absent	10	100.0	10	100.0	

Week 4					
Present	0	0.0	0	0.0	NA
Absent	10	100.0	10	100.0	
Week 24					
Present	0	0.0	0	0.0	NA
Absent	10	100.0	10	100.0	

Chi-sqaure test, NA-Not applicable

Table-7 & Fig. 7 shows the comparison of the pus discharge between the groups at time intervals. The pus discharge was observed in 30% patients of Group I and in 20% of Group II at pre-op which remained at Day 7, however, the difference was statistically not significant (p>0.05). The pus discharge became nil in both the groups after Day 7.

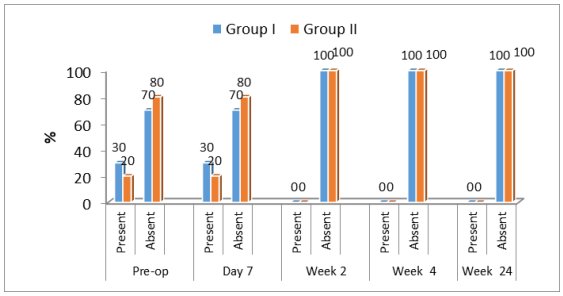


Fig 7: Comparison of pus discharge between the groups at different time intervals

Table 8: Comparison of Percentage bone fill between the groups at different time intervals

Time intervals	Group I	Group II	p-value[1]
Week 2	11.30±0.70	16.74±1.18	0.0001*
Week 4	62.44±4.55	68.50±3.30	0.003*
Week 24	92.96±1.44	95.52±1.98	0.004*

Unpaired t-test, *Significant

Table-8 & Fig. 8 shows the comparison of the percentage bone fill between the groups at time intervals. The percentage bone fill was significantly (p<0.01) lower in Group I than Group II at week 2, 4 and 24 weeks.

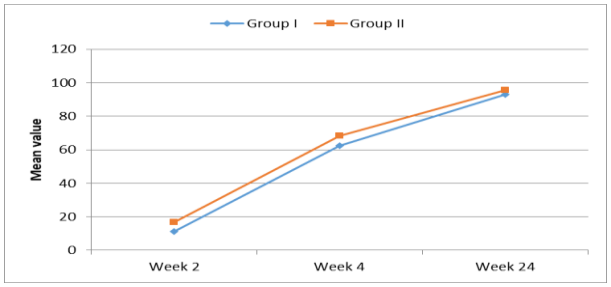


Fig 8: Comparison of Percentage bone fill between the groups at different time intervals

Table 9: Comparison of Complications (gape, discharge, extrusion of graft, nerve injury) between the groups at different time intervals

Time intervals	gape				Discharge				Extrusion of graft				nerve injury			
	Group I		Group II		Group I		Group II		Group I		Group II		Group I		Group II	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Day 7																
Present	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Absent	10	100	10	100	10	100	10	100	10	100	10	100	10	100	10	100
Week 2																
Present	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Absent	10	100	10	100	10	100	10	100	10	100	10	100	10	100	10	100
Week 4																
Present	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Absent	10	100	10	100	10	100	10	100	10	100	10	100	10	100	10	100
Week 24																
Present	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Absent	10	100	10	100	10	100	10	100	10	100	10	100	10	100	10	100

[1]Chi-sqaure test, NA-Not applicable

Table-9 shows the comparison of complications between the groups at time intervals. The gape was found to be absent in both Group I and Group II at all the time intervals. The pus discharge was found to be absent in both Group I and Group II at all the time intervals. The extrusion of graft was found to be absent in both Group I and Group II at all the time intervals. The nerve injury was found to be absent in both Group I and Group II at all the time intervals.

DISCUSSION

Calcium phosphate based bioceramics have been used in medicine and dentistry for nearly two decades. Applications include dental implants,percutaneous devices, and use in periodontal treatment, alveolar ridge augmentation, maxillofacial surgery, otolaryngology, orthopedics, and spinal surgery.[9]
Repair can be defined as healing of an injured tissue that leads to the formation of a tissue that differs in morphology or function from the original tissue.[10] Regeneration is used to describe healing that leads to complete restoration of morphology and function. The biphasic structure of BCP ceramics, characterized by different degradation rates for HA and β-TCP, accounts for their controlled bioactivity. BCP ceramics present intermediate degradation behavior, so that their progressive resorption and ultimate replacement are adapted to bone in growth.[11]
It has been hypothesized that the biphasic nature of this ceramic serves two basic functions: i) initiates cell growth and differentiation; and ii) acts as a scaffold for cell maturation and bone formation, i.e., having the property of osteoinductivity.[12]

In our study group mean age of patients in group I was 30.20 years with standard deviation of 11.84 while for that of group II it was 25.30 years with standard deviation of 9.61.There was no significant ($p>0.05$) difference in the age between Group I (30.20±11.84) and Group II (25.30±9.61). There were 50% males and 50% females in group I while in group II, there were 30% males and 70% females. There was no significant ($p>0.05$) difference in the gender between Group I and Group II. The results were in accordance with the study of Griffith et al.[13]

We observed no significant ($p>0.05$) difference in the VAS pain score between both the groups at different time intervals. There was no significant ($p>0.05$) difference in the VAS at pre-op and Day 7 between the groups and became similar after Week 2.

There was no significant ($p>0.05$) difference in the swelling at pre-op and Day 7 between the groups and became nil after Day 7.In our study the tooth mobility was absent in both the groups at pre-op. The grade I tooth mobility was observed in 50% patients of Group I and in 40% patients of Group II, however, the difference was found to be statistically insignificant ($p>0.05$). The tooth mobility became absent after Day 7 in both the groups. The palpable lymph node was observed in 30% patients of Group I and in 20% of Group II at pre-op which remained at Day 7, however, the difference was statistically not significant ($p>0.05$). The palpable lymph node became nil in both the groups after Day 7.We observed pus discharge in 30% patients of Group I and in 20% of Group II at pre-op which remained at Day 7, however, the difference was statistically not significant ($p>0.05$). The pus discharge was absent in both the groups after Day 7.These findings were in congruence with study by Daculsi et al.[14] The percentage bone fill was significantly ($p<0.01$) lower in Group I than Group II at week 2, 4 and 24. Previous studies have shown that biphasic calcium phosphate (BCP) has osteoconductive potential. The development of biphasic calcium phosphate ceramic made it possible to control the resorbability of tricalcium phosphate and at the same time maintain the osteoconductive potential of hydroxyapatite. Results of the previous study on tissue response to biphasic calcium phosphate ceramic with different ratios of HA/β-TCP in periodontal osseous defects have indicated that the ratio of HA to β-TCP in the ceramic implant influenced periodontal wound healing when used in the treatment of chronic osseous defects in dogs. Higher HA/β-TCP ratio tended to show greater gain in attachment level, accompanied by accelerated new bone formation as shown histologically. When β-TCP was removed from the ceramic component, using only 100% porous HA, the gain was found to be less than that of the groups that received ceramic containing β-TCP. This may be due to the low dissolution rate of porous HA. Since this study showed that the combination of HA and β-TCP has better new attachment level and bone regeneration, it would indicate that β-TCP plays an important role in cell

proliferation, revascularization, and osteogenesis.Our graft granule too had 60% hydroxyapatite and 40% β-TCP which served two basic functions a)cell growth and differentiation b)scaffold for cell maturation and bone formation. The postsurgical results obtained both clinically and radiographically, showed predictable clinical outcome. Manjubala et al. studied the bone in-growth induced by biphasic calcium phosphate ceramic in femoral defect of dogs. BCP ceramic composed of 55% hydroxyapatite (HA) and 45% β-tricalcium phosphate was grafted in femoral defects of dogs. In this study, radiographic results showed that the process of ossification started after 4 weeks of grafting, and the defect was completely filled with new woven bone after 12 weeks. Histological examination of the tissue showed the formation of osteoblast inducing the osteogenesis in the defect. The collagenous fibrous matrix and the complete Haversian system were observed after 12 weeks. The blood serum was collected postoperatively, and biochemical assays for alkaline phosphatase activity were carried out. The measurement of alkaline phosphatase activity levels also correlated with the formation of osteoblast-like cells. Gape, graft extrusion and paresthesia was absent in either of the groups probably relating to the size of the defect and in agreement to the study by Manjubala et al.[15]

CONCLUSION

Biphasic calcium phosphate ceramics consist of both β-tricalcium phosphate and hydroxyapatite. The alliance of these two components allows bioactivity to be controlled through a combination of HA and β-TCP properties. Previous studies have shown that biphasic calcium phosphate (BCP) has osteoconductive potential.

The development of biphasic calcium phosphate ceramic made it possible to control the resorbability of tricalcium phosphate and at the same time maintain the osteoconductive potential of hydroxyapatite. In the light of our present study we conclude that hydroxyapatite and beta tricalcium phosphate are totally safe & biocompatible for use in human with no aggravation of any inflammatory response when used as graft material and faster bone healing was achieved too.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

REFERENCES

1. Karl. F.B Payne et al “Tissue Engineering Technology And Its Possible Applications In Oral And Maxillofacial Surgery” British Journal Of Oral And Maxillofacial Surgery 52, 2014; 7–15.

2. Di Silvio L.Bone tissue engineering and biomineralization. In: Boccaccini A R, Gough J E,editors. “Tissue engineering using ceramics and polymers.” Boca Raton: CRC Press,2007;p.319–34. 9.

3. Urist MR, Kovacs S, Yates KA “Regeneration Of An Enchondroma Defect Under The Influence Of An Implant Of Human Bone Morphogenetic Protein”. J Hand Surg [Am] 1986;11(3):417—9.

4. D.L. Cochran, A.A. Jones, L.C. Lilly, J.P. Fiorellini, H. Howell, “ Evaluation of recombinant human bone morphogenetic protein-2 in oral applications including the use of endosseous implants: 3-year results of a pilot study in humans.” J. Periodontol. 71,2000 1241–1257.

5. Marx RE. Clinical application of bone biology to mandibular and maxillary reconstruction. Clin Plast Surg 1994; 21(3):377–92.

6. Lane JM, Yasko AW, Tomin E, Cole BJ, Browne M, Turek T, and other. Bone marrow and recombinant human bone morphogenetic protein-2 in osseous repair. Clin Orthop Relat Res 1999; 361: 216–27.

7. Moghadam HG, Urist MR, Sándor GK, Clokie CM. Successful mandibular reconstruction using a BMP bioimplant. J Craniofac Surg 2001;12(2):119–27.

8. Clokie CM, Urist MR. Bone morphogenetic protein excipients: comparative observations on poloxamer. Plast Reconstr Surg 2000; 105(2):628–37.

9. Bessho K, Tanaka N, Matsumoto J et al., Human dentin-matrix-derived bone morphogenetic protein. Journal of Dental Research, 1991;70: 171-175.

10. Constam DB & Robertson EJ, Regulation of bone morphogenetic protein activity by prodomains and proprotein convertases. Journal of Cell Biology, 1999;144: 139-149.

11. Wozney JM, Rosen V, Celeste AJ et al., Novel regulators of bone formation: molecular clones and activities. Science, 1988;242: 1528-1534.

12. Spinella-Jaegle S, Roman-Roman S, Faucheu C et al., Opposite effects of bone morphogenetic protein-2 and transforming growth factor-beta1 on osteoblast differentiation. Bone, 2001;29: 323-330.

13. Griffith DL, Keck PC, Sampath TK et al., Three-dimensional structure of recombinant human osteogenic protein 1: structural paradigm for the transforming growth factor beta superfamily. Proceedings of the National Academy of Sciences, USA, 1996;93: 878-883.

14. Daculsi G, LeGeros RZ, Lynch NE, Kerebel B. Transformation of biphasic calcium phosphate ceramica in vivo: Ultrastructural and physiochemical characterization. J Biomed Mater Res 1989;23:883-94.

15. Manjubala I, Sastry TP, Kumar RV. Bone in-growth induced by biphasic calcium phosphate ceramic in femoral defect of dogs. J Biomater Appl. 2005:341–60.