ORIGINAL RESEARCH

Evaluation of Hydroxyapatite Granules, CERAMENT™, and Platelet-rich Fibrin in the Management of Endodontic Apical Surgery

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Abstract

Aim: The present study compared hydroxyapatite granules, CERAMENT™, and platelet-rich fibrin (PRF) in the management of endodontic apical surgery cases.

Materials and methods: The present study was conducted on 126 patients requiring apical surgery of both genders. Patients were treated with hydroxyapatite granules, CERAMENT™, and PRF and were recalled regularly for assessment of pain, mobility, presence or absence of sinus, and healing site.

Results: The mean days taken for the disappearance of pain in group I was 51.2 days, in group II was 52.3 days, and in group III was 44.7 days. The difference was significant ($p < 0.05$). There was a less number of draining sinuses in II and III groups. This was statistically significant ($p < 0.05$). Significantly less area remained after surgical intervention in groups II and III compared to group I recorded at follow-up period. The difference was significant ($p < 0.05$).

Conclusion: Authors found PRF superior in terms of reducing pain, mobility, and sinus and improving the healing site as compared to hydroxyapatite and CERAMENT™.

Clinical significance: Platelet-rich fibrin is considered more superior in terms of reducing pain, mobility, and sinus and improving the healing site, and it can be advised in clinical practice for endodontic management.

Keywords: Apical surgery, CERAMENT™, Hydroxyapatite, Platelet-rich fibrin.

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Introduction

Endodontic management of teeth with pulpal involvement is important for long-term survival of teeth. In cases of persistence of periapical lesion, endodontic apical surgery plays a major role. Endodontic surgery ensures complete removal of pathological lesion at the apex of involved tooth. Periapical lesion such as periapical cyst, granuloma, and abscess are frequently encountered in routine day life.[1]

There are some instances where conventional root canal treatment is not possible due to the limitations such as root canal obstruction, root canals with irretrievable materials, persistent signs and symptoms, etc. The success of endodontic therapy depends upon certain factors such as complete removal of microorganisms from periapical lesions, age of the patient, general health of the patient, etc.[2] A success rate of 81–87% has been reported following apical endodontic surgery. Guided tissue regeneration techniques are attracting interest in adjunct apical surgery. The healing of apical region is important to ensure successful treatment.[3]

Different materials such as allografts, xenografts, and alloplasts are available in the market for grafting of osseous defects. Among all, autografts do not provoke immune reactions and hence are the best replacement material, whereas autogenous graft material has the risk of morbidity of donor site to some extent.[4] Numerous bone graft materials are widely used. Hydroxyapatite ceramic granules of the dimension 0.5 to 1 mm with a hole dimension of 100 to 200 µm are effectively used following apical surgery. CERAMENT™ is another useful bone graft material which comprises 60% calcium sulfate and 40% hydroxyapatite mixed with iohexol. A platelet-rich fibrin (PRF) is an excellent healing agent and proven to be the material of choice in the management of endodontic apical surgery.[5]

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There is a lack of studies on the use of hydroxyapatite granules, CERAMENT™, and PRF in the management of endodontic apical surgery cases. Hence, the present study was undertaken with the objective to evaluate clinically and radiographically the healing process following periapical surgery and assess pain, mobility, swelling, and vitality of adjacent teeth after endodontic apical surgery.

Materials and Methods

This study was carried out in the Department of Conservative Dentistry and Endodontics, DY Patil Dental School, Lohegaon, Pune, Maharashtra, after obtaining approval from the institutional ethics committee and written consent from participants. The study comprised 126 patients requiring apical surgery, who were equally divided among both the genders based on three different study materials, namely, hydroxyapatite granules, CERAMENT™, and PRF.

Sample size estimation was done by using the below formula, where N is population size, $\hat{p}$ is the population proportion, z is the z score, n and n' are the sample sizes. Sample size of 126 was obtained from total population of 600 at 95% confidence level, i.e., confidence interval of 7.77.

Unlimited population:

$$\text{CI} = \hat{p} \pm z \times \sqrt{\frac{p(1-p)}{n}}$$

Finite population:

$$\text{CI}' = \hat{p} \pm z \times \sqrt{\frac{\hat{p}(1-\hat{p})}{n'} \times \frac{N-n'}{N-1}}$$

Data such as name, gender, age, etc., were obtained from participants. Inclusion criteria comprised patients aged between 18 years and 38 years with periapical lesions such as periapical abscess, cyst, and granuloma in the maxillary anterior region and systemic healthy patients with failed conventional root canal filling with pain and sinus tract. Exclusion criteria were medically compromised patients and patients with a smoking habit or periodontal disease.

In apical surgery, an effective infection control procedure was followed. The area was anesthetized using 2% xylocaine with 1:30,000 adrenaline. A rectangular flap with two vertical and a sulcular incision was given and the mucoperiosteal flap was elevated and reflected. After obtaining bony access, the periapical curettage was performed to remove the diseased tissue surrounding the root apex.

Patients were divided into three groups of 42, and each material (group I: hydroxyapatite granules, group II: CERAMENT™ bone graft, and group III: PRF) was inserted in the bony defect in the respective group. Following this, the flaps were repositioned and sutured. Patients were prescribed antibiotics and analgesics. Preoperative and postoperative radiographs were taken by following the paralleling technique. Patients were recalled regularly to record healing, pain, mobility (Miller's classification), and sinuses. All cases were assessed clinically and radiographically at the recall visit after 1 month, 3 months, 6 months, 9 months, and 1 year.

The pain was assessed based on the following scoring criteria: 0 = absence of pain on percussion, 1 = mild pain, 2 = moderate, and score 3 = severe pain. Mobility was assessed based on criteria as follows: grade I, normal labiolingual (1 mm); grade II, labiolingual mobility >1 mm; and grade III, labiolingual mobility >2 mm and vertical mobility. Preoperative and postoperative presence of draining sinus, swelling, and vitality of adjacent teeth were scored in the observation chart as (+) and (–). Vitality was evaluated with thermal testing.

Radiographic evaluation for healing was observed with regard to the presence of trabecular bone formation and size of the lesion and graded as follows: score 1: radiopaque than bone, score 2: irregular radiopacity, and score 3 uniform radiopacity.

The obtained data were evaluated using SPSS version 21 (IBM, Chicago, USA). Analysis of variance (ANOVA) and student t tests were applied. The p values less than 0.05 were considered statistical significant.

Results

Table 1 shows that the mean days taken for the overcoming pain in group I was 51.2 days, in group II was 52.3 days, and in group III was 44.7 days. It was statistically significant ($p < 0.05$). Table 2 indicates that there was fewer cases of draining sinus in groups II and III (1 case after 1 year follow-up) as compared to group I (2 cases after 1 year). The difference was significant ($p < 0.01$). Swelling in adjacent area was observed in 1, 3, and 4 cases, respectively, in groups III, II, and I; mobility in 0, 1, and 3 cases in groups III, II, and I, respectively; and adjacent teeth vitality in 28, 24, and 20, respectively, in groups III, II, and I (Table 3, and Fig. 1), which was statistically significant ($p < 0.05$)

Table 4 shows that significantly less area in cm^2 remained after surgical intervention in groups II (0.01) and III (0.05) as compared to group I (0.2) at the follow-up period, and the difference was significant ($p < 0.05$).

Discussion

The main purpose of periapical surgery is to obtain complete repair of the osseous defects. Insufficient bone healing is caused by the

Table 1: Duration of days taken for disappearance of pain

Group	*Mean*	*SD*	*t value*	*p value*
Group I	51.2	3.7	7.12	0.05
Group II	52.3	4.2		
Group III	44.7	5.1		

Student t test, significance, $p < 0.05$

Table 2: Assessment of draining sinus in all groups

Time period	*Group I*	*Group II*	*Group III*	*t value*	*p value*
Pre	30	28	26	7.22	0.01
1 month	28	22	20		
3 months	12	16	14		
6 months	6	8	7		
9 months	2	1	2		
1 year	2	1	1		

Student t test, significance $p < 0.05$

Table 3: Assessment of swelling and mobility after 1 year follow-up

Time period	*Group I*	*Group II*	*Group III*	*t value*	*p value*
Swelling	4	3	1	5.14	0.01
Mobility	3	1	0		
Vitality	20	24	28		

Student *t* test, significance $p < 0.05$

Table 4: Assessment of area in cm^2 after surgical intervention in all groups

Time period	*Group I*	*Group II*	*Group III*	*F*	*p value*
Pre	1.4	1.6	1.5	18.23	0.02
1 month	1.2	1.3	1.1		
3 months	1	0.9	0.8		
6 months	0.9	0.5	0.2		
9 months	0.3	0.1	0.5		
1 year	0.2	0.01	0.05		

ANOVA test, significance $p < 0.05$

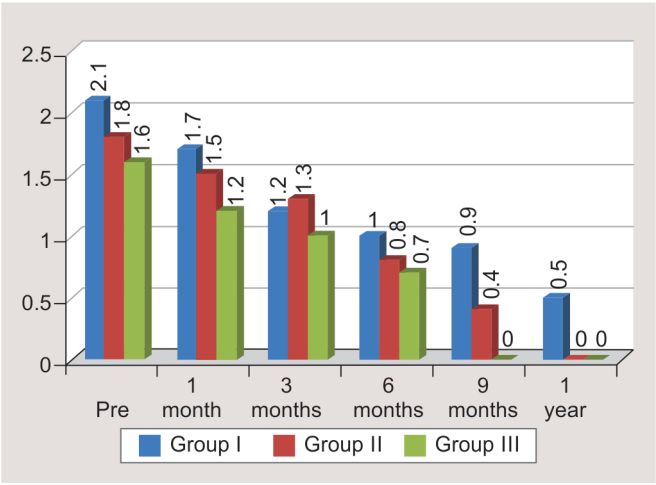

Fig. 1: Comparison of mean mobility of teeth in all groups

in-growth of connective tissue into the bone space, which prevents osteogenesis. To avoid this soft tissue in-growth, bone substitute may prove helpful to fill the bony space.[6]

The healing of the decayed tissue either by regeneration or by repair depends on the availability of cell types needed and the presence or absence of signals necessary to stimulate these cells. The tissue-engineering approach to bone regeneration combines three elements which include stem cells or progenitor cells, conductive scaffolds or extracellular matrix, and signaling molecules. Different bone grafts with different properties have been studied and tried in various cases.[7]

Hydroxyapatite crystals offer the potential of an unlimited supply of bone substance, absence of donor site morbidity, and decreased operative time. Slower healing of lesions was observed with hydroxyapatite crystals. Hydroxyapatite granules are available as white granules measuring 100–350 mm in size. It is biocompatible, not immunogenic nor antigenic.[3,8–10]

The PRF is a rich source of growth factors (helps in wound healing and promotes tissue regeneration) with autologous leukocyte. It is produced by not adding anticoagulant, and it is considered to be osteoinductive, second-generation platelet concentrate. It has unique properties of effective tissue regeneration and repair. The PRF preparation generates a fibrin network related to normal process, which helps in more proficient cell movement and production. The PRF is a platelet gel that offers several advantages such as bone growth and maturation, graft stabilization, and promotes wound healing.[8,9]

CERAMENT™ is another useful drillable bone graft material which is an injectable and moldable radiopaque bone graft and it is an osteoconductive material.[10,11]

The present study compared hydroxyapatite granules, CERAMENT™, and PRF in the management of endodontic apical surgery cases. We found that pain disappeared in less time in groups I and III compared to group II. Wälivaara et al. in their study assessed the healing of bone defects following apical surgery which were filled with ChronOS®, Tigran™ PTG, CERAMENT™ bone void filler, or Easygraft® CLASSIC or left vacant. The authors found no statistical significant difference between the materials.[11]

In the present study, we found a less number of draining sinus in groups II and III as compared to group I. Singh et al. in their study evaluated the role of PRF in the regeneration of surgical site in 15 cases. All the 15 cases were found to be completely healed at the end of 6 months, and all patients showed complete bone regeneration. The authors suggested that PRF may be effectively used in apical surgery cases to promote healing and regeneration of bone.[12] The PRF is considered a well-off supply of platelet-contained growth factor (PDGF), transforming growth factor (TGF), and insulin-like growth factor (IGF). The IGF-1 is synthesized and secreted by osteoblasts, which stimulates bone formation. Human osteoblast proliferation has been observed with a combination of epidermal growth factor and PDGF, IGF-I, and TGF.[9,12]

We also found a significantly less area remained after surgical intervention in groups II and III as compared to group I at follow-up period. Alnemer et al. reported a case in which surgical enucleation of the cystic lesion was performed on 52-year-old female patient, and the site was filled with bone graft. Both clinical and radiographic examination revealed a good healing at the 6-month follow-up.[13]

Thanikasalam et al. conducted a study to evaluate the bone regeneration in the periapical region using platelet-rich fibrin (PRF) and nanocrystalline hydroxyapatite (NcHA) with collagen in combination with PRF over control group, and patients were recalled at 1, 3, and 6 months. After 6 months, a significantly higher rate of healing was observed in PRF with NcHA patients

compared to other groups.[9] Uppada et al. in their case series stated that radiographic healing outcome with decreased postoperative discomfort was found with a combination of amnion membrane with a bone graft and PRF.[14] Liu et al. stated that *in vitro* PRF was able to stimulate cell proliferation, differentiation, migration, mineralization, and osteogenesis-related gene expression.[15]

We found less pain, swelling, and mobility at postoperative follow-up after 1 year in groups III and II compared to group I. This could be because of the healing growth factors present in the PRF. Vinod Kumar and Indu Raj found less postoperative pain, swelling, and mobility with the Chitra hydroxyapatite granule group compared to the control group.[16]

Because of the release of growth factors, faster healing and relief of symptoms were observed from PRF gel in our study compared to hydroxyapatite granules and CERAMENT™. Our result helps in the practice of primary care by using PRF in healing the surgical area after endodontic apical surgery.

The shortcoming of this study is the small sample size. The selection of more bone materials in increased number of patients could have been providing different results. However, large-scale studies are required to obtain better results with other materials.

Conclusion

The authors found PRF superior in terms of reducing pain, mobility, and sinus and improving the healing site as compared to hydroxyapatite and CERAMENT™.

References

1. Vijay P, Singhal I, Singh N, et al. Radicular cyst and its management: a case report. Int J Dent Med Res 2015;1(5):80–81.
2. Dwivedi S, Dwivedi CD, Chaturvedi TP, et al. Management of a large radicular cyst: a non-surgical endodontic approach. Saudi Endod J 2014;4(3):145–148. DOI: 10.4103/1658-5984.138149.
3. Elgendy EA, Abo Shady TE. Clinical and radiographic evaluation of nanocrystalline hydroxyapatite with or without platelet-rich fibrin membrane in the treatment of periodontal intrabony defects. J Indian Soc Periodontol 2015;19(1):61–65. DOI: 10.4103/0972-124X.148639.
4. Chogle SM, Goodis HE. Regenerative endodontics. Dent Clin North Am 2012;56(3):495–698. DOI: 10.1016/j.cden.2012.05.009.
5. Kumar V, Raj I. Healing of periapical bone lesion after periradicular surgery and graft placement - clinical and radiographic evaluation. J Med Dent Sci Res 2017;4(4):10–23.
6. Deenadayalan E, Kumar A, Tewari RK, et al. Management of large preiapical lesion with the combination of second generation platelet extract and hydroxyapatite bone graft: a report of three cases. J Clin Diagnost Res: JCDR 2015;9(1):24.
7. Goyal L. Clinical effectiveness of combining platelet rich fibrin with alloplastic bone substitute for the management of combined endodontic periodontal lesion. Restor Dent Endod 2014;39(1):51–55. DOI: 10.5395/rde.2014.39.1.51.
8. Zhao JH, Tsai CH, Chang YC. Management of radicular cysts using platelet-rich fibrin and bioactive glass: a report of two cases. J Formos Med Assoc 2014;113(7):470–476. DOI: 10.1016/j.jfma.2011.09.027.
9. Thanikasalam M, Ahamed S, Narayana SS, et al. Evaluation of healing after periapical surgery using platelet-rich fibrin and nanocrystalline hydroxyapatite with collagen in combination with platelet-rich fibrin. Endodontology 2018;30:25–31.
10. Pradeep AR, Bajaj P, Rao NS, et al. Platelet-rich fibrin combined with a porous hydroxyapatite graft for the treatment of 3-wall intrabony defects in chronic periodontitis: a randomized controlled clinical trial. J Periodontol 2017;88(12):1288–1296. DOI: 10.1902/jop.2012.110722.
11. Wälivaara DÅ, Abrahamsson P. Evaluation of 4 different bone graft substitutes and autogenous bone grafting in root-end resection osteotomies after retrograde root-filling with intermediate restorative material (IRM): an experimental study in dogs. Open J Stomatol 2013;3(02):203. DOI: 10.4236/ojst.2013.32035.
12. Singh S, Singh A, Singh S, et al. Application of PRF in surgical management of periapical lesions. Natl J Maxillofac Surg 2013;4(1):94–99. DOI: 10.4103/0975-5950.117825.
13. Alnemer NA, Alquthami H, Alotaibi L. The use of bone graft in the treatment of periapical lesion. Saudi Endod J 2017;7:115–118.
14. Uppada UK, Kalakonda B, Koppolu P, et al. Combination of hydroxyapatite, platelet rich fibrin and amnion membrane as a novel therapeutic option in regenerative periapical endodontic surgery: case series. Int J Surg Case Rep 2017;37:139–144. DOI: 10.1016/j.ijscr.2017.06.009.
15. Liu Y, Sun X, Yu J, et al. Platelet-rich fibrin as a bone graft material in oral and maxillofacial bone regeneration: classification and summary for better application. Bio Med Res Int 2019;9:1–16. Article ID 3295756 | 16 pages.
16. Vinod Kumar P, Raj I. Healing of periapical bone lesion after periradicular surgery and graft placement- clinical and radiographic evaluation. J Med Dent Sci Res 2017;4(4):10–23.