Research Article

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Periradicular Surgery-Radiograpgic and Planimetric Evaluation

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ABSTRACT

Aim: The efficacy of guided bone regeneration technique in periradicular surgery by clinical and radiographic evaluation.

Materials and Methods: A randomized clinical trial was conducted in which patients were assigned for periradicular surgery with guided bone regeneration technique [guided tissue regeneration membrane placed over hydroxyapatite bone graft in the bony defect, with 10 patients in group. Clinical and radiographic evaluation was performed at 1 month, 3 months and 6 months after the surgery.

Results: Ten patients with an average age of 23.8 years having periapical lesions were assigned for periradicular surgery. Clinical and radiographic examination was performed 1 month, 3 months and 6 months after the surgery. There was a significant difference found between the percentage reduction of the sizes of the radiographic periapical lesions.

Conclusion: The use of bone regenerative materials, such as bioabsorbable membranes and resorbable hydroxyapatite improved the predictability of clinical and radiographic healing.

Keywords: Guided bone regeneration, periapical defects, bone grafts, guided tissue regeneration membrane.

INTRODUCTION

Most periapical radiolucent lesions heal uneventfully after endodontic therapy. However, some cases may require periradicular surgery in order to remove pathological tissue from the periapical region and simultaneously eradicate any sources of irritation that could not be removed by orthograde root canal treatment.[1]

Apical surgery is often considered a last resort to preserve a tooth when conventional endodontic retreatment is not feasible or is associated with therapeutic risks.[2] The alternative treatment would be tooth extraction, or in multi-rooted teeth, root or tooth resection.

Indications for apical surgery include: [3]

1. Radiological findings of apical periodontitis which are not amenable for endodontic therapy.

2. Extruded material with clinical or radiological findings of apical periodontitis and/or symptoms continuing over a prolonged period.

3. Persisting or emerging disease following root canal treatment.

4. Perforation of the root or the floor of the pulp chamber and when it is not permeable to treat from within the pulp cavity.

The main objective of apical surgery is to create an optimal environment for periradicular tissue healing. This is usually accomplished by removing pathology or removing inaccessible parts of the root

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canal system, and by preventing reinfection from the root canal system. For this purpose, a retrograde cavity is prepared following root-end resection, and a filling material is placed into this cavity to completely seal the root canal system at the resection level.[3]

Regeneration of periapical bone defects constitutes a significant problem in periradicular surgery, since the proliferation of gingival connective tissue or the migration of the oral epithelium into such defects can occur and prevent the formation of normal trabecular bone.[1] The application of the principles of guided tissue regeneration (GTR) to endodontic surgery has been the focus of several clinical trials and experimental studies

research both in humans and animals.4 The objective of GTR in endodontic surgery is to enhance the quality and quantity of bone regeneration in the periapical region and to accelerate bone growth in circumscribed bony cavities after endodontic surgery. Guided bone regeneration (GBR) is the application of the concept of GTR to osseous defects.[5] Autogenous bone is found to be the most effective bone graft material because of its osteogenic potential. However, this graft is limited in quantity and there is an associated morbidity with the harvesting procedure requiring an additional surgery, so various synthetic bone grafting materials have been developed in order to avoid the possible discomfort and complications.

Bone substitute materials share numerous advantages over autografts such as un-limited supply, ease of sterilization, and storage. Extensive research studies have shown that calcium phosphate ceramic biomaterials are safe and effective for a variety of restorative and preservative clinical applications. A form of calcium phosphate ceramic (hydroxyapatite) contributes to the major portion of bone (60-70%) and teeth (98%).6In appropriate synthetic form, hydroxyapatite is generally observed to be 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. It 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. Application of a membrane barrier is indicated during periapical surgery to prevent apical migration of junctional epithelium along the denuded root surface into the periapical wound and to induce selective repopulation of cells of the connective tissue attachment.[7]

Collagen barrier membranes are particularly suitable for GTR applications, as collagen is chemotactic and stimulate proliferation of fibroblasts, acts as a barrier for migrating epithelial cells, provides hemostasis, has low antigenicity and high tensile strength. It can serve as a fibrillar scaffold for vascular and tissue ingrowth. It also can be easily shaped, and is readily adaptable. These membranes are resorbed by the enzymatic activity of macrophages and neutrophils.[8]

SOURCE OF DATA

This clinical study was undertaken on outpatients attending the Department of Oral and Maxillofacial Surgery and Department Of Endodontics, Sri Hasanamba Dental College and Hospital for treatment of periapical pathologies. The study conformed to the ethical guidelines and was approved by the institutional Ethics Board.

MATERIALS AND METHODS

A randomized clinical trial was conducted in which patients satisfying the inclusion criteria, as listed below, were assigned for periradicular surgery.

Inclusion criteria:

1. The tooth to be treated surgically should show a periradicular lesion and in which nonsurgical treatment alone is considered insufficient or retreatment is considered unfeasible or had previously failed.

2. The minimum diameter of the bone defect, as will be determined from the periapical radiographs, should be at least 1 cm x 1cm in diameter.

3. Patients with no general medical contraindication for oral surgical procedures (American Society of Anaesthesiologists [ASA]-1).

Exclusion criteria:

1. Teeth with vertical root fractures or traumatic injuries.

2. Teeth with external or internal root resorption.

3. Teeth with perforation of the furcation area or lateral canal walls.

4. Severe periodontal bone loss detected with a periodontal probe (probing depth greater than 5 mm).

Study population: Each patient was given written information stating about the surgical procedure and possible discomforts and risks. Patients were informed of their participation in a randomized trial. Written consent was obtained from the patients /guardians who participated in the study. Presurgical therapy: A thorough clinical examination, oral prophylaxis, intraoral periapical radiograph and routine haematological examination was carried out prior to surgery. Source of hydroxyapatite: In the present study, pre-sterilized synthetic resorbable hydroxyapatite-BIOGRAFT-HA (IFGL Bio Ceramic product; ISO 9001-2000 certified) has been used in particulate form. The hydroxyapatite granules were white in colour with a granule size of 300-500 microns.

Source of collagen membrane: In the present study, resorbable type I collagen membrane-PerioCol-GTR (Eucare Pharmaceuticals Ltd) has been used. The membrane contained fibrillar sterile collagen of fish origin and measured 25×30 mm.

Surgical procedure

Periradicular surgery was carried out only in the absence of acute symptoms. All patients were treated under local anaesthesia. Surgical procedure included the elevation of appropriate mucoperiosteal flap, osteotomy, periradicular curettage, enucleation, apicectomy and root end filling was done by glass ionomer cement. The armamentarium used in the study is shown in.

The following operative protocol was strictly followed:

1. Full mouth scaling, plaque removal and patient instructions for oral hygiene procedures.

2. Preoperative intraoral betadiene and saline irrigation was done to reduce the risk of contamination of the surgical field.

3. Local anaesthesia was achieved with 2% lignocaine hydrochloride with 1:80,000 adrenaline.

4. Full thickness mucoperiosteal tissue flap was raised. The flap designs (triangular or rectangular, marginal or submarginal) varied according to the periodontal status.

5. Surgical access to the root was then gained through cortical bone with the use of a round bur. The bur was used at a low rotary speed under constant copious saline irrigation.

6. The periradicular lesion was removed with sharp bone curettes. Curetted tissue was kept in 10% formalin solution for histopathological diagnosis.

7. After the root end was exposed, 2.5 to 3 mm root end was resected with a bevel using straight fissure bur.

8. Preparation of the cavity for root-end filling was done and root-end filling was done with glass ionomer cement.

9. In cases with defect was filled with hydroxyapatite granules and covered with resorbable collagen membrane.

10. Reflected tissues were reapproximated to their original position and sutured with nonabsorbable 3-0 silk.

Post operative care

1. Antibiotic cover with Amoxicillin 500 mg each thrice daily was given for 5 days.

2. Analgesics were prescribed: Diclofenac Sodium 50 mg + Paracetamol 325mg thrice a day for 5 days.

3. Patient motivation and reinforcement of oral hygiene was carried out. Chlorhexidine mouth rinse was carried out for 2 weeks postoperatively.

4. Sutures were removed one week postoperatively.

Clinical evaluation:

Clinical assessment was done by subjective and objective criteria as given by Gutmann.17 Patients

were evaluated 1 week, 1 month, 3months and 6 months postoperatively for the following parameters:

a. Mobility of involved tooth: Grade I, II or III
b. Tenderness on palpation: present or absent
c. Sinus: present or absent
d. Paresthesia: present or absent
e. Infection/swelling: present or absent
f. Sensitivity to percussion: present or absent

Radiographic evaluation

Intraoral periapical radiographs were taken prior to surgery, and 1 month, 3 months and 6 months after surgery. All the radiographs were taken using Rinn XCP parallel cone technique with the graduated lead grid (Figure 2) in place next to the IOPA film. Radiographic analysis was done by comparing the initial size of the lesion on the preoperative film with the images on the follow up film. An achromatic magnifying lens was used to measure the lesion area in cm2 by planimetry (Figure 3) and the percentage reduction on the final radiograph.

Fig 2: IOPA with grid.

Fig 3: Planimetry Device.

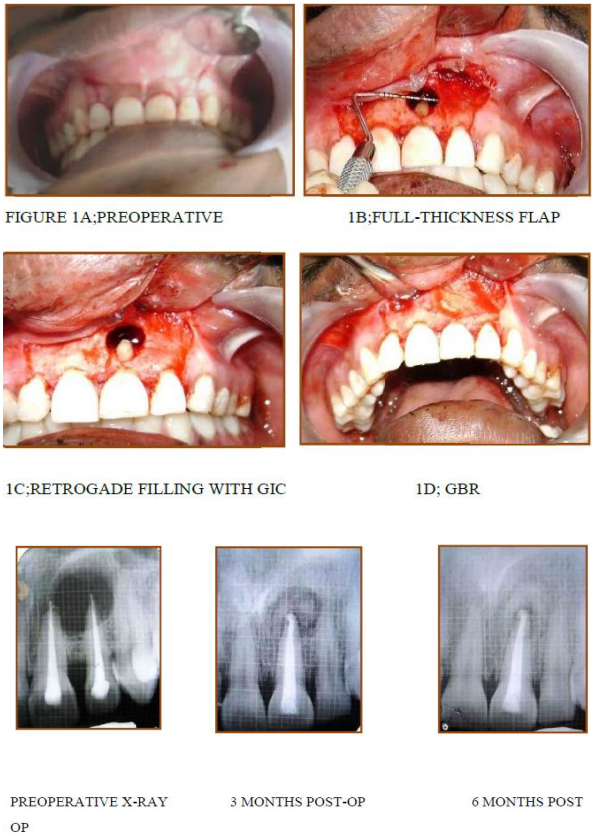

FIGURE 1A;PREOPERATIVE 1B;FULL-THICKNESS FLAP

1C;RETROGADE FILLING WITH GIC 1D; GBR

PREOPERATIVE X-RAY OP 3 MONTHS POST-OP 6 MONTHS POST

Table 1: Percentage reduction in size of the lesion.

Pre op size of the lesion (cm2)	Mean	6 months post op size of the lesion (cm2)	Mean	Percentage reduction
1.2	1.81	0.1	0.15	91.71%
2.5		0.1		
2.75		0.2		
2.35		0.2		
3.2		0.2		
1.3		0.1		
1.6		0.2		
1		0.1		
1.2		0.2		
1		0.1		

DISCUSSION

A number of studies have been evaluated the results after periradicular surgery, using diverse clinical and radiographic parameters. In some studies, success rates under 50% were reported, whilst others had success rates of even 100%.4This wide variation in the results is a reflection of the multiplicity of surgical concepts, materials and methods used; differences in the criteria over which the healing parameters are based on, the

observation periods, age groups studied, and differences between patients, teeth and selection criteria.

I. Demographic variables:

1. Age: The mean age of the patients included in the study was 23.8 years almost similar to other studies.

2. Gender: Out of 10 patients, 5 were male and 5 were females.

3. Site: The site most commonly involved in this study was upper anterior teeth. 9 sites were in the maxillary anterior teeth and 1 site was in mandibular anterior teeth.

4. Size of the lesion: According to Pecora et al.4the size of the lesion may be a critical factor because the distance between hard and soft tissues could determine the type of tissue that will grow during healing. If fibrous tissue establishes itself first, it will probably act as a barrier to prevent bone formation. Several studies have shown that the prognosis of smaller lesions after periradicular surgery was better than the prognosis of larger ones.[21] Pecora et al.10 evaluated the healing of periapical lesions of more than 10 mm, and showed clinical and radiographic evidence of complete bone regeneration, when the membrane technique was used as a barrier. In the present study the mean size of the lesions was 1.81cm^2. When regeneration techniques were used in this study, the lesions of larger size had healed faster in 6 months.

II. Guided bone regeneration:

1) Hydroxyapatite bone graft: Synthetic hydroxyapatite C10(PO4)6(OH)2, has been in use since more than 30 years. It is the primary mineral found in bone. Kandaswamy and Ramchandran[11]in 2000 proved the advantages of hydroxyapatite over other bone grafts in periapical surgery. Hydroxyapatite is not osteogenic nor osteoinductive, but rather is osteophillic and osteoconductive.

Various advantages of synthetic hydroxyapatite are:[11]

a. Excellent biocompatibility
b. No donor site is required
c. Easy to use
d. No risk of transmission of disease
e. It acts as a framework for the ingrowth and subsequent deposition of new bone.

The biocompatibility of the hydroxyapatite granules as evidenced by minimum clinical inflammation, infection or swelling during the healing phase was demonstrated in this study. According to Fucini et al[20] larger particles take longer time to resorb and remain longer at the augmentation site.

In the present study pre-sterilized synthetic resorbable, particulate hydroxyapatite of 300-500 micrometer in size was used. This resorbable form is a non-sintered (nonceramic) precipitate. It has been proposed that non-sintered hydroxyapatite resorbs acting as a mineral reservoir inducing bone formation via osteoconductive mechanisms.20Its reported advantage is the slow resorption rate, allowing it to act as a mineral reservoir at the same time acting as a scaffold for bone replacement.[20]

2) Guided tissue regeneration membrane: Barrier membrane techniques or osteopromotion procedures use a barrier to prevent other tissues, especially connective tissue from entering the intended site of bone reformation and from interfering with osteogenesis. Membrane may also provide additional wound coverage, acting as a duplicate surgical flap to provide added stability and protection of the blood clot and preventing ruptures along the interface between the healing tissues and the root surface. Membranes provide a tent like area for the blood clot, creating a space under surgical flap that will act as the scaffold for the ingrowth of cells and blood vessels from the base of the lesions.[8]

Collagen possesses several characteristics that make it a suitable barrier material, including favourable effects on coagulation and wound healing, controlled crosslinking, low antigenecity and fibre orientation.8Various studies done by Taschieri et al, [9] Dietrich et al[13] and Britain et al[14] yielded good results on using bioresorbable collagen membrane in periradicular surgeries. Studies have shown no difference in bone tissue healing if only the buccal cortical plate was destroyed, whether or not a membrane barrier was used in periapical surgery.[21] To maximize periodontal tissue regeneration wound healing

must not be adversely affected or compromised by a rapid resorptive or inflammatory response to the membrane.[12] The results of the present study demonstrate that bioresorbable collagen membrane does not compromise the healing process.

The main advantage of using resorbable membrane is the avoidance of a second surgical procedure, thus reducing patient morbidity and expense.8 In the present study, resorbable type I collagen membrane (PerioCol-GTR) derived from fish sources was used which was gamma sterilised.There were minimal postoperative complications, a good healing rate and no incidence of material dehiscence, tissue perforation, sensitivity reactions, tissue sloughing, delayed healing or postoperative infection.

Post operative evaluation:

A. Clinical evaluation:Clinical assessment was done by subjective and objective criteria as given by Gutmann.[17]

Tenderness on palpation: In the present study, evaluation of pain in the follow up period after periapical surgery was based on a simple descriptive or ordinary verbal scale. The visual analogue scale (VAS) is also considered to be a valid and reliable ratio scale for measurement of pain. However, it is well known that pain perception is a highly subjective and variable experience modulated by many factors. Therefore, in this study, the level of discomfort was based on simple descriptive scale to simplify pain rating and because of the ease of computation. While in some patients pain was present in 70% of the patients in first week post operative (p=0.36) and then in 10% of the patients in sixth postoperative month. Likewise, swelling was present in 50% of the patients after one week. Sensitivity to percussion of the involved teeth was present in one patient after one week which is insignificant. There was no post operative paresthesia seen. Persistence of sinus tracts was seen in 2 patients after one week and in one patient after one month with an insignificant p value.

Radiographic evaluation:

Published studies use different criteria to determine the prognosis of periapical surgery, with no general agreement between them. There are clinical healing criteria based on patient signs and symptoms; while others, such as Rud et al, 15 used only radiographic studies. The von Arx and Kurt scale16 uses a combination of clinical and radiographic parameters. The healing classification most used in the literature is that of Rud et al.19In the present study the radiographic assessment was done by comparing the initial size of the lesion on the preoperative film with the images on the follow up film. A graduated lead grid was used with the film while taking radiograph. All the radiographs were taken using parallel cone technique which is in contrast with other studies.18The paralleling technique produces an image that has dimensional accuracy, is free of distortion and exhibits maximum detail and definition. This technique is easy to standardize and can be accurately duplicated or repeated when serial radiographs are indicated.22 An achromatic magnifying lens was used to measure the lesion area in cm2 by planimetry and the percentage reduction on the final radiograph was calculated. This helped us in assessing the results quantitatively and objectively.

Tobon S I et al1 in their study used three techniques and evaluated the radiographic healing, a year after surgery in group A (conventional technique), there were four out of nine cases with complete healing, in group B (barrier technique) there were six out of nine cases with complete healing and in group C (barrier technique and hydroxyapatite) all the cases had complete healing.

The radiographic assessment up to three months revealed no significant percentage reduction in size of the lesion, but there was 68% in size of the lesion from 3rd to 6th month. The statistical analysis established a significant difference between the final values of the sizes of the radiographic periapical lesions in our group. Thus, the use of guided bone regeneration techniques, allows a more predictable healing response by the action of a double mechanism: firstly, the membrane allows the re-population of the defect with regenerative cells derived from the periodontal ligament and the endosteum; and secondly, the bone graft acts as reservoir and matrix for the deposition of new bone. There are few limitations in the present study. First, the small sample size in association with the variability of bone defects might have influenced

the results. A study with more patients would have greater statistical power and precision. Secondly, healing was evaluated on the evidence of the radiographic appearance. This has limitations, as the nature of the tissues that have formed within the healed lesions is unknown. A histological examination is required to collect this type of information. Because of ethical reasons and in order to keep the healing undisturbed, histological evaluation was not done in this study. Finally, all clinical measurements were performed by one examiner who was not blinded to the study which may have introduced bias.

CONCLUSION

The bone regeneration following periradicular surgery can be facilitated by using bone graft and barrier membrane. Hydroxyapatite and the use of resorbable membrane are found to be very effective for guided bone regeneration technique. On the basis of review of literature and the clinical and radiographic outcomes, it was concluded that the conventional technique was less predictable in its healing response during the 6 months. The use of bone regeneration materials, such as bioabsorbable membranes and resorbable hydroxyapatite improved the predictability of clinical and radiographic healing.

The results when considered within the limitations of this study indicate that:

1. Excellent post surgical healing response to guided bone regeneration technique with no adverse complications.

2. The simultaneous use of a bioabsorbable membrane and a synthetic resorbable hydroxyapatite graft produced satisfactory regeneration of bone as consistently observed clinically and radiographically. More conclusive studies are required with high level of evidence concerning membrane barriers and /or bone grafts in periapical surgery.

CONFLICTS OF INTEREST

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

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