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Guided Tissue Regeneration in Surgical Endodontic Treatment: Case Report and Literature Review

SUMMARY

***Background/Aim**: Guided tissue regeneration is widely used in endodontic surgery. The aim is to aid in the healing process and bone regeneration and provide more successful and predictable outcomes.* ***Case report**: This case report describes the successful treatment of an endodontic-periodontal lesion (with primary endodontic involvement), including root canal retreatment and endodontic surgery with the use of GTR (collagen absorbable membrane-xenogeneic bone graft). CBCT examination was used to aid in diagnosis and in the follow-up examination after two years to provide additional confirmation of the healing process. An extensive literature review was undertaken focusing on clinical studies that assessing the added benefit of GTR in surgical endodontics. The clinical and radiographic examinations showed uneventful healing and the reconstruction of the buccal plate and periapical area. The patient remained asymptomatic throughout the entire two years period after surgical intervention. A literature review concluded that lesion type, lesion size and the selection of the biomaterial are important factors that influence the outcome of GTR in comparison control groups. A favorable outcome was found in cases of large periapical lesions (>10mm), through-through lesions and with the use of an absorbable membrane, with or without a bone graft.* ***Conclusions**: GTR is thought to provide an added benefit in bone regeneration and the healing process in specific cases. The outcomes in the case report are consistent with the conclusions of literature review.*

Key words: Endodontic Surgery, Guided Tissue Regeneration, Membranes, Bone Grafts

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Introduction

Endodontic surgery is a treatment option for teeth with apical periodontitis and is also indicated for teeth where root canal treatment has failed and non-surgical retreatment is difficult, impractical or unlikely to have a successful outcome[1,2]. Following endodontic surgery, periapical wound healing can be led towards repair or regeneration, depending on various factors such as the type and size of lesion and the availability of cells from the host and biological factors potentially stimulating the wound healing process in the damaged area[3-5]. This has led experimental and clinical studies to focus on GTR (Guided Tissue Regeneration) techniques to enhance the effectiveness and predictability of periapical healing. Guided tissue regeneration is a technique for directing cell growth towards specific areas of the periodontium damaged by periodontal disease, endodontic pathology or trauma[6]. Tissue engineering comprises three key elements; stem cells, scaffold biomaterials and growth factors. Stem cells are cells capable of differentiation into one or more cell types and act as a repository of immature stem cells[7,8]. Scaffold biomaterials are three dimensional structures conducive to hosting cells, directing growth, differentiation and cell immigration[9,10]. Growth factors, on the other hand, are proteins that bind to receptors on cells and induce cellular proliferation and differentiation[11].

Guided tissue regeneration principles are implemented in endodontic surgery by the use of bioactive materials such as bone grafts and membranes, either

alone or in combination. Their function is to encourage growth of key surrounding tissues while excluding unwanted cell types such as epithelial cells from the area of regeneration[12]. The purpose of this paper is to present a case of an apico-marginal defect in a second mandibular premolar which was treated by endodontic surgery and the use of GTR techniques. The case report is followed by a literature review including the application of regenerative procedures in endodontic surgery.

Case Report

A healthy 22-year-old female patient presented at our private practice with intraoral swelling in the lower right quadrant. Clinical examination revealed acute pain on percussion and palpation in the apical area of #35. In addition, a pocket depth of 12mm was detected mesiobuccally and Class II mobility was present. The patient's history revealed a recent failed attempt at retreatment on tooth # 35. Periapical radiographs revealed a bony defect in addition to the presence of overextended gutta-percha in the apical area (Figure 1). Initial diagnosis was symptomatic apical periodontitis. The overall classification of this case was that of an endodontic-periodontal combined defect. Since marginal periodontitis was absent, this suggested that there was a primary endodontic involvement in the case. According to the Von Arx classification this case was allocated to the 2b category[13]. The patient was referred for a CBCT examination. The CBCT scan confirmed the presence of extruded gutta-percha and revealed an extended bony defect which included the buccal plate of #35 (Figure 2, 3).

Figure 1. Overextended gutta-percha in the apical area

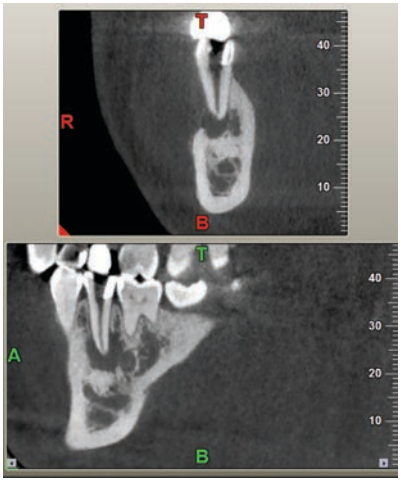

Figure 2. Extended bony defect including the buccal plate of #35

Figure 3. CBCT scan confirming the presence of the extruded gutta-percha and revealing an extended bony defect

A treatment plan was decided on which included the retreatment of the tooth in conjunction with periapical surgery involving the use of GTR. Root canal retreatment was performed; the previous obturation materials removed; the root canal was shaped and cleaned with nickel-titanium rotary instruments (Protaper F4, DentsplySirona, USA) under copious irrigation with NaOCl3%. The root canal was then dried with sterile paper cones and $Ca(OH)_2$ applied as an inter-appointment medicament for a week. At the next visit, the root canal was obturated laterally compacted with gutta-percha and AHplus (Dentsply Maillefer, USA) sealer followed by temporary restoration, with periapical surgery being scheduled for later. During this surgical procedure, a full-thickness triangular flap was raised extending from the distal aspect of #36 to the distal aspect of #33 due to anatomical restrictions associated with the mental nerve. A buccal bony fenestration was noted over the root of #35, covered by granulation tissue. Granulation tissue was also present in the surrounding of apical area. After degranulation, the extruded fragment of gutta-percha was removed. Xenogenous bone chips (Cerabone, Botiss) were gently packed into the apical area and the buccal fenestration, and then an absorbable collagen membrane (Remaix, Matricel) was secured. The flap was repositioned and secured with 4 single interrupted sutures. Post-operative instructions were given, which included one week course of amoxicillin 1 g twice a day and 0.12 % chlorhexidine mouth rinse. After one week the sutures were removed.

One year follow up examination presented a clinically significant reduction of tooth mobility and the elimination of the periodontal pocket (Figure 4). Periapical radiographs revealed the absence of the apical lesion, which has been replaced by the formation of calcified tissue. In the 2 year follow up a cone-beam CT

scan was performed for pre-surgical assessment prior to the extraction of #38. This revealed the reconstruction of the buccal plate and periapical area (Figures 5-7). The patient's periodontal condition was good with adequate oral hygiene. The patient remained asymptomatic throughout the entire two year period after the surgical intervention.

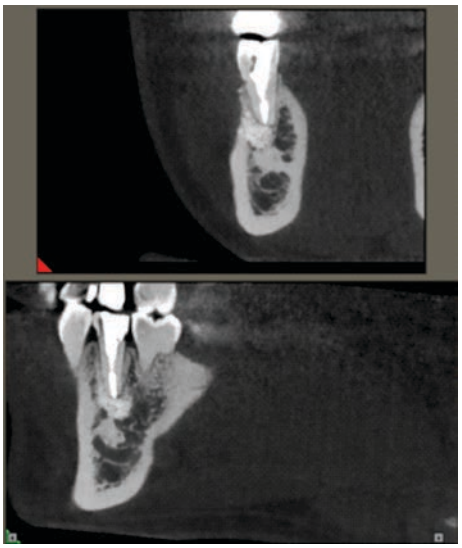

Figure 5. CBCT scan revealing the reconstruction of the buccal plate and periapical area after 2 years' follow up

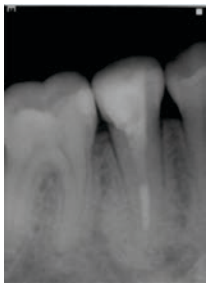

Figure 4. Periapical radiograph revealing the absence of the apical lesion after 1 year follow up

Figure 6. CBCT scan in apical area after 2 years' follow up

Figure 7. CBCT scan in middle and cervical third after 2 years' follow up

Discussion

The most commonly used classification of bone defects associated with endodontic surgery is Von Arx and Cohran's classification; described here in Table 1.

Table 1. Classification of bony defects in endodontic surgery from Von Arx and Cochran 2001

Classification of bone defects in endodontic surgery from von Arx and Cochran 2001	
Class 1: Bony defects localized to periapical area	
1a: Lingual/Palatal cortex is not eroded	1b: Erosion of buccal and lingual/palatal cortex(through-through lesions)
Class 2: Apico-marginal lesions	
2a: Periapical and marginal lesions without communication	2b: Periapical and marginal lesions with communication
Class 3: Lateral juxtaradicular lesion	
3b: Without communication to alveolar crest	3b: With communication to alveolar crest

The results of the search are presented after the categorization of the clinical and experimental reviews according to the Von Arx classification. The first class includes bone defects confined to the periapical region. The majority of clinical human and animal studies have not reported a significant benefit regarding bone fill after the use of GTR in 1a class of defects. More specific a randomized clinical trial was performed by Garret *et al*. 2002, 25 patients was randomly divided into two groups of different treatment type[14]. The first group was treated with periapical surgery with the use of polylactide membrane (Guidor-Sunstar, Chicago, IL, USA) and the control group was treated with periapical surgery without membrane. The osseous defect was confined to apical area with bone covering coronally and lingually. At 3, 6,12 months recalls, radiographs was compared with digital means. The study demonstrated that there was no statistical difference between the two groups and also showed that the placement of a bioresorbable membrane in Class Ia lesions has no beneficial effect regarding rate of healing[14]. In one experimental study, periapical defects were induced in dog's teeth. The surgical sites were divided in four groups. The first group was covered with membrane (bovine cortical membrane, GenDerm-Genius Pharm Ltl), the second group was filled with a combination of bone graft and membrane, third group only bone grafts was used and finally forth group was

control group. After 6 months, the results were evaluated. There was no statistically difference among experimental groups[15.] These results go along with the experimental study conducted by Bergenholtz, where the potential of recombined human bone morphogenetic protein-2 to enhance bone healing after periapical surgery in 1a lesion was tested. Results showed that rhBMP-2 along with an absorbable collagen sponge did not offer an obvious benefit comparing with control cases[16]. Another experimental study was performed, where apical periodontitis was induced in nine cats and root canal treatment was combined with periapical surgery. Bone defects were divided into four groups- group 1: ABBM (atelocollagen bovine bone mineral); group 2: ABBM and collagen membrane; group 3: collagen membrane only; group 4: control. This study showed a significantly more bone formation when biometarials were used and interestingly concluded that the key factor influencing periapical regeneration is rather membrane than bone graft[17]. These results go along with some other studies which have demonstrated a faster healing process after the use of membrane or bone grafts in combination with PRP[18,19]. Regarding category 1b lesions (through-through lesion), the vast majority of the studies we reviewed demonstrated a statistically significant improvement in the healing process and some significant indications of regeneration. A prospective clinical study was performed in order to assess the periapical healing after periapical surgery in teeth with through-through lesions. Thirty-four teeth were divided into two groups. In first group the lesions were filled with ABBM and collagen membrane and in the second group neither graft nor membrane was used. After 1 year, first group presented better outcomes (88%) than control group (57,1%) regarding periapical healing[20]. Another randomized clinical study investigated the rate of healing of periapical surgery with and without the use of calcium sulphate in 1b lesions. Results showed that calcium sulphate improved the rate of healing and the prognosis[21]. These findings are consistent with the outcomes of other studies[22]. The second class includes apico-marginal lesions, which present a serious challenge in endodontic surgery. The main factor in a poor therapeutic prognosis for these cases is the long junctional epithelium formation migrating into the periodontal pocket[23]. This is exemplified by the success rate of treating apico-marginal lesions without the use of GTR procedures being in the range of 27%-37 %[24,25]. The primary use of absorbable membrane with the use of bone grafts in some circumstances exhibits the best clinical outcomes in terms of bone formation, reduction of periodontal pocket depth and clinical attachment levelgain[26-28]. One clinical study evaluates the healing of apicomarginal defects after periapical surgery with the use of bone grafts in combination with collagen membrane. After 12 months, the success rate was nearly 83%, showing that GTR techniques in these cases boost periapical and periodontal healing[29]. In one experimental study, periodontic-endodontic lesions were induced in foxhounds. Three different treatment protocols were performed. An open flap debridment (OFD) was in the first group. The second group was treated with OFD in combination with a bioabsorbable collagen membrane and the third with OFD, collagen membrane and anorganic bovine bone matrix. After 6 months clinical, radiographic and histologic examination were performed. The authors concluded that GTR techniques resulted on an increased amount of bone formation in addition to increased cementum formation in root surfaces[30]. The third class includes lateral juxtaradicular lesions. Based on our research, no available articles or studies regarding this defect class are presently extant in the literature.

The present case report involves a 2b category defect (Von Arx and Cohran classification). The treatment protocol applied, included a combination of an absorbable collagen membrane and a xenogeneic bone graft. The particular treatment protocol was chosen after reviewing the available literature, as mentioned above. The collagen membrane used, is composed of a network of highly purified porcine collagen fibers intermingled with highly purified porcine elastin fibers. The xenogeneic bone graft is derived from the mineral phase of bovine bone which shows a high resemblance to human bone regarding surface porosity and chemical composition[31] and has also been exposed to high temperatures to eliminate all organic components[32-35] and inactive prions[36] to minimalize immunological reactions. On follow-up examinations, bone regeneration was adequate and there was a satisfying improvement in the periodontal status of #35. These results are consistent with the conclusions of the literature review.

Another factor influencing the success rate of endodontic surgery is lesion size. Even in non-surgical root canal treatment, the size of lesion is a major factor in determining the rate of the healing process[37,38]. Usage of guided tissue regeneration in large lesions (>10mm), according to a series of clinical studies, significant improves clinical outcomes regarding periapical area regeneration in comparison with control groups where there was no use of GTR techniques[39]. Nonetheless, a clinical study by Taschieri et al 2007 40 showed that in large lesion (>10mm) GTR techniques did not present the expected outcome, since the healing process followed the pathway of repair rather than regeneration.

When a more detailed look is taken at membrane biomaterials, absorbable membranes have more favorable outcomes than non-absorbable ones[38]. This could well be the consequence of non-absorbable membranes requiring a second surgery intervention for removal[41]. Regarding bone grafts, the available literature conclude that, although, autogenous grafts present the most advantages such as osteo-genic behavior and low cost, the need for a donor site limits their use[41]. Grafts

widely used in clinical practice and widely documented in clinical and experimental studies are allografts, xenografts from bovine bone, hydroxyapatite and tricalciumsulphate[21,39,42-44].

Although the ability of bone grafts or/and membranes to boost bone regeneration is well-documented; periodontal ligament and cementum regeneration remains unpredictable. This indicates that GTR techniques might not result in complete regeneration of periapical tissues after endodontic surgery. To fully understand tissue regeneration, more information is needed, including details of the various molecular and biological processes involved in the formation of each tissue in the periapical area. In addition, the fact that the host's blood clot can provide an excellent natural scaffold in healing process should not be overlooked. There are many biomaterials now available to promote regeneration, but currently regenerative techniques have a limited potential in terms of predictable regeneration. It is crucial for clinicians to know all the factors that negatively influence the outcome of GTR and strict cases selection should be implemented regarding this.

Conclusions

This case report reveals that GTR techniques using collagen membrane and xenogeneic bone graft can be an efficient treatment option with satisfactory bone regeneration in apico-marginal bony defects in single-root teeth caused by endodontic-periodontal lesion with primary endodontic involvement.

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