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Evaluation of regenerative periodontal therapy following root canal treatment in endodontic–periodontal lesions

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Abstract:
Combined endodontic-periodontal lesions require coordinated management of endodontic infection and periodontal tissue destruction. This prospective comparative study evaluated 60 patients receiving root canal treatment, followed by either conventional periodontal therapy or regenerative periodontal therapy. At 6 months, regenerative therapy produced significantly greater probing pocket depth reduction (3.93±0.81 vs. 2.76±0.72 mm), clinical attachment level gain (3.71±0.78 vs. 2.47±0.69 mm) and radiographic bone fill (58.7±12.4% vs. 34.8±10.6%) ($p<0.001$). Regenerative periodontal therapy resulted in superior periodontal healing following root canal treatment compared with conventional therapy. These findings advance knowledge by supporting regenerative periodontal therapy as a beneficial approach for periodontal healing in combined endodontic-periodontal lesions.

Keywords: Endodontic–periodontal lesion, periodontal regeneration, root canal treatment, bone graft, guided tissue regeneration (GTR), clinical attachment level

Background:
Endodontic-periodontal lesions are mixed lesions which affect both pulpal and periodontal tissues. Despite their close anatomical connection with each other via the apical foramen, dentinal tubules and lateral and accessory canals, microorganisms and inflammatory mediators can easily pass through between the pulp and periodontium **[1]**. Therefore, such lesions can feature deep pockets, attachment loss, alveolar bone destruction, pulpal necrosis and varying tooth mobility **[1].** Early diagnosis and classification is crucial to identification of endodontic–periodontal lesions, their source, extent and the most effective approach to management. Leaders attend the 2017 World Workshop to learn more about the classification of endodontic–periodontal lesions, which are divided into those with or without root damage as well as patients with or without periodontitis **[2].** Combining the two types of disease (true combined lesions) will be one of the biggest challenges in which leaders will engage. In general, the extracanal infection (both the offending bacteria and the resulting lesion) is treated first to allow for healing of the endodontic portion of the wound, thereby improving the healing of the extracanal (outside of the canal) infection **[3]**. But, if significant periodontal attachment and osseous destruction remains, periodontal intervention is needed. In combined endodontic–periodontal lesions, much success has been achieved with combined surgical techniques, including several bone grafting materials, guided tissue regeneration (GTR) or other regenerative biomaterials **[4].** Periodontal regenerative procedures are intended to regenerate lost periodontal tissues - alveolar bone, periodontal ligament and cementum **[5]**. The use of different types of regenerative biomaterials has been proved effective in the treatment of periodontal intrabony defects, with the potential for further improvements in clinical outcomes if the proper biomaterial is selected based on the characteristics of the defect **[6, 7].** Therefore, it is of interest to assess the regenerative periodontal therapy after RCT in combined endodontic-periodontal lesions patients.

Materials and Methods:
Study design and study population:
This study was designed as a prospective comparative clinic study of 60 patients with a diagnosis of combined endodontic–periodontal lesions. The patients required endodontic and periodontal treatment were screened clinically and radiographically and selected based on specific treatment parameters.

Inclusion criteria:
Patients included were between 18 to 60 years of age, who had combined endodontic–periodontal lesions, non-vital tooth with probing pocket depth (PPD) ≥5 mm and clinical attachment loss (CAL) with radiographic evidence of periodontal bone loss. Tooth selection was limited to teeth that could be restored and had sufficiently good periodontal supporting tissues to allow regenerative procedures to be performed.

Exclusion criteria:

Patients who had an uncontrolled systemic disease; were pregnant or lactating; had vertical root fractures; teeth were non-restorable; teeth were highly mobile with a hopeless prognosis; had received recent periodontal surgery at the selected site; or had conditions or medications that were known to factor into periodontal wound healing were excluded.

Preoperative assessment:
An in-depth history of each patient was taken. The following parameters were evaluated: pulp vitality, percussion, palpation, tooth mobility, periodontal probing depth, clinical attachment level, Plaque Index and Gingival Index. Intraoral periapical radiographs were taken to assess size and shape of periodontal and periapical bone loss.

Endodontic treatment:
Firstly, all selected teeth were subjected to conventional RCT. Local anesthesia and rubber dam were placed, access cavity was created and working length was determined. The cleaning and shaping were performed with the aid of rotary instrumentation and sodium hypochlorite irrigation. Adequate disinfection was then carried out and the canal was dried before obturation was made with gutta-percha and an appropriate root canal sealer. A complete coronal restoration was then offered. All patients were recalled and the condition of the periodontal tissues was reassessed before periodontal surgery.

Group allocation and periodontal treatment:
The 60 patients were allocated into two groups of 30 patients each:

Group i (n=30): conventional periodontal therapy:
Periodontal flap surgery was conducted for patients after their root canal therapy. Flap reflection and debridement and removal of the granulation tissue as well as root surface instrumentation were carried out. The flap was re-set and then sutured in place.

Group ii (n=30): regenerative periodontal therapy:
Root canal treatment and flap reflection were followed by full debridement and root surface instrumentation. An appropriate bony defect (PD) was treated with or without a guided tissue regeneration membrane (GTR) made from a bone graft/regenerative biomaterial formulation. Flap was then relocated and sutured for a proper closure. Post-operative care and periodontal maintenance were given to all patients in both groups.

Outcome assessment:
Clinical parameters were obtained at 0, 3 and 6 months. The following variables were considered:
[1] Probing pocket depth (PPD)
[2] Clinical attachment level (CAL)
[3] Plaque Index
[4] Gingival Index
[5] Tooth mobility
Baseline and 6-months standardized intraoral radiographs were taken. Standardized measurement was used to assess radiographic changes of the periodontal defect and to measure the percentage of bone fill. The main outcome measures were decreases in PPD and increases in CAL. The secondary outcomes were gingival changes, tooth mobility and radiographic bone fill.

Statistical analysis:
Microsoft Excel used to enter data and SPSS software was used to analyze of data. Continuous variables presented as mean with SD and frequencies and percentages for categorical. Statistically, within group changes in clinical parameters were assessed with the help of paired statistical tests, while intergroups changes were conducted using independent Student's t-test or otherwise appropriate nonparametric statistical tests. Chi-square or Fisher's exact test were used for the comparison of categorical variables. Statistically significant was defined as a p value < 0.05.

Results:
Sixty patients with combined endodontic–periodontal lesions were assessed. Thirty patients were treated with root canal and conventional periodontal flap (Group I) and 30 patients were treated with root canal and regenerative periodontal therapy (Group II). Up to 6 months all the patients were assessed. At initial measurement the two groups were matched in terms of age, sex distribution, periodontal indices, PPD and CAL. No baseline differences were observed and were not found to be statistically significant (p> 0.05) **(Table 1)**. For both groups, PPD has decreased gradually. At 6 months, mean PPD decreased to 4.42 ± 0.74 mm in Group I and 3.31 ± 0.68 mm in Group II. The mean reduction of periodontal pockets was significantly higher with regenerative periodontal therapy (3.93 ± 0.81 mm) than in conventional periodontal therapy (2.76 ± 0.72 mm; p<0.001) **(Table 2).** Both groups made gains in clinical attachment in the follow-up period. Group II had significantly higher mean CAL gain (3.71 ± 0.78 mm) than Group I (2.47 ± 0.69 mm; p<0.001), which means that the periodontal attachment of the group receiving regenerative treatment has improved more **(Table 3).** After treatment, there was an improvement in the periodontal status in both groups. There was no significant difference between the groups for Plaque Index 6 months (p=0.296); however, Gingival Index for Group II was significantly lower (p=0.012). The regenerative group (58.7 ± 12.4%) had significantly larger radiographic bone fill than the conventional group (34.8 ± 10.6%, p<0.001). In both groups the mobility of the teeth has also decreased, with less mobile teeth remaining in the Group II, but this difference was not statistically significant (p=0.166) **(Table 4).**

Table 1: Baseline demographic and clinical characteristics of the study groups

Parameter	Group I(n=30)	Group II(n=30)	p-value
Age (years), mean ± SD	39.6 ± 8.4	40.2 ± 8.1	0.780
Male, n (%)	17 (56.7%)	16 (53.3%)	0.795
Female, n (%)	13 (43.3%)	14 (46.7%)	
Plaque Index	1.72 ± 0.34	1.69 ± 0.31	0.723
Gingival Index	1.81 ± 0.38	1.78 ± 0.35	0.752
Probing pocket depth (mm)	7.18 ± 0.91	7.24 ± 0.88	0.795
Clinical attachment level (mm)	7.83 ± 1.02	7.89 ± 0.97	0.816

Table 2: Comparison of probing pocket depth at different follow-up periods

Time point	Group I (mm), mean ± SD	Group II (mm), mean ± SD	p-value
Baseline	7.18 ± 0.91	7.24 ± 0.88	0.795
3 months	5.12 ± 0.82	4.48 ± 0.76	0.003*
6 months	4.42 ± 0.74	3.31 ± 0.68	<0.001*
Reduction from baseline to 6 months	2.76 ± 0.72	3.93 ± 0.81	<0.001*

**Statistically significant at p<0.05.*

Table 3: Comparison of clinical attachment level at different follow-up periods

Time point	Group I (mm), mean ± SD	Group II (mm), mean ± SD	p-value
Baseline	7.83 ± 1.02	7.89 ± 0.97	0.816
3 months	6.14 ± 0.88	5.42 ± 0.83	0.002*
6 months	5.36 ± 0.81	4.18 ± 0.75	<0.001*
CAL gain at 6 months	2.47 ± 0.69	3.71 ± 0.78	<0.001*

**Statistically significant at p<0.05.*

Table 4: Comparison of secondary clinical and radiographic outcomes at 6 months

Parameter	Group I (n=30)	Group II (n=30)	p-value
Plaque Index	0.92 ± 0.23	0.86 ± 0.21	0.296
Gingival Index	0.88 ± 0.26	0.72 ± 0.22	0.012*
Radiographic bone fill (%)	34.8 ± 10.6	58.7 ± 12.4	<0.001*
Teeth with mobility at baseline, n (%)	15 (50.0%)	16 (53.3%)	0.796
Teeth with mobility at 6 months, n (%)	7 (23.3%)	3 (10.0%)	0.166

**Statistically significant at p<0.05.*

Discussion:

The clinical effectiveness of RPT after RCT was evaluated in the case of combined endodontic–periodontal lesions in the present study. Conventional periodontal flap therapy showed improvement in periodontal parameters, whereas regenerative treatment showed statistically significant reductions in probing pocket depth (PPD), improvements in clinical attachment level (CAL) and fills in radiographic bone at 6 months. The difference in mean PPD reduction between the two groups was 3.93 ± 0.81 mm versus 2.76 ± 0.72 mm in the regeneration and conventional groups, respectively (p<0.001). The sequence and timing of endodontic and periodontal treatment could also have an impact on healing, as supported by Needleman *et al.* who have shown positive outcomes with GTR in intrabony defects in the periodontium **[8].** But Dong *et al.* emphasized that the timely timing of the root canal treatment and periodontal regenerative surgery in severe combined lesions is essential **[9].** Ruetters *et al.* **[10]** found that endodontic treatment alone produced improvements in probing pocket depth and clinical attachment level in some grade 3 endodontic–periodontal lesions without root damage, although treatment outcomes were not highly predictable. This finding highlights the importance of assessing the response to endodontic treatment and the residual periodontal defect when planning subsequent periodontal intervention. Results showed a significantly greater CAL gain after regenerative therapy (3.71 ± 0.78 mm) as compared to conventional therapy (2.47 ± 0.69 mm). The goal of regenerative approaches is to replace the missing PDAPP, not just repair it **[11].** The current management of endodontic–periodontal lesions also seeks the harmonization of appropriate periodontal treatment that varies depending on the size of the periodontal defect and appropriate endodontic disinfection **[12]**. Endodontic–periodontic regeneration can also benefit from the use of enamel matrix derivatives. The percent of radiographic bone fill was significantly higher for the regenerative group (58.7 ± 12.4%) than for the conventional group (34.8 ± 10.6%; p<0.001). Improved bone generation might be caused by the regenerative ability of bone graft or biomaterial in a meticulously debreded periodontal defect. Annunziata *et al* showed good regeneration results with enamel matrix derivatives and grafts have also been shown in pooled intrabony defect analyses while Stavropoulos *et al.* reported sustained clinical benefits of regenerative/reconstructive procedures for periodontal intrabony defects **[13, 14].** An excellent result of periodontal regeneration has also been reported in intrabony defects with regenerative or reconstructive treatments over period of time, as shown by Lee *et al.* **[15].** The present findings are of special interest in combined endodontic–periodontal lesions. Rosen *et al.* also reported that using guided tissue regeneration might lead to better results in teeth with associated endodontic and periodontal involvement **[16].** A favourable clinical and inflammatory result was also described following bone grafting in the treatment of endodontic–periodontal lesions **[17].** Suresh *et al.* **[18]** reported improvements in clinical parameters and radiographic bone gain following regenerative periodontal therapy for endodontic–periodontal lesions, with a reported five-year survival rate of 92.33%. These findings support the potential for favourable outcomes following regenerative treatment, although differences in study design, biomaterials and follow-up duration should be considered when comparing results. Furthermore, Fang *et al.* showed beneficial clinical and inflammatory outcomes when root canal therapy was combined with periodontal treatment **[19].** Additionally, a systematic scoping review by Ardila and Vivares-Builes showed that combined therapeutic approaches may yield favourable results; however, the variation in lesion characteristics or treatment protocol may have a negative impact on treatment success **[20].** This study had some limitations as the sample size was relatively small and the duration of the study was for a period of only 6 months. Long-term stability of regenerative outcome in larger studies with longer follow-up periods and with standardised 3-D radiographic assessment is necessary. Long-term evidence from De Ry *et al.* **[21]** showed that clinical improvements following periodontal regenerative surgery with enamel matrix derivative could be maintained over a mean follow-up of 10.3 years, although tooth loss and clinical attachment deterioration remained possible. Such findings reinforce the importance of extended follow-up when evaluating the durability of regenerative outcomes.

Conclusion:

In combined endodontic–periodontal lesions, regenerative periodontal therapy after root canal treatment showed better clinical and radiographic results than traditional periodontal flap surgery. Using the regenerative approach, more PPD reduction and CAL gain as well as more radiographic bone fill were reported. Therefore, adequate endodontic treatment followed by periodontal regeneration may be a successful means of restoring

adequate periodontal support and prognosis of endodontically treated teeth.

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