Original Article

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Effect of cervical lesions on the rate of survival without fracture in endodontically treated premolars with exposed proximal cavity and restored with resin composite

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Objectives: This retrospective study aimed to investigate the effect of an additional cervical lesion on the rate of survival without fracture in endodontically treated teeth (ETT) with exposed occluso-proximal cavity and restored with direct resin composite, and to identify the predisposing factors of fracture.
Materials and Methods: Clinical and radiographic records of patients who received endodontic treatment and direct resin composite restoration in premolars during 2011-2020 were reviewed. Data regarding premolar ETT with exposed occluso-proximal cavity- with (CII+V) and without (CII) the cervical lesion, were analyzed. Incidences of postoperative fracture were identified and categorized into 'restorable' or 'non-restorable'. Cumulative survival rates of CII and CII+V were compared using Kaplan-Meier survival analysis and log-rank test (p-value = 0.05). Cox proportional hazard model was used to identify any potential risk factors for fracture.
Results: In the 102 premolar ETT analyzed from 89 patients, 53 and 49 teeth were CII and CII+V, respectively. With a recall period of 30.7±16.4 months, There is no significant difference in the cumulative survival rate without fracture between CII (49/53, 92.5%) and CII+V (44/49, 89.8%). For the fractured ETT, a higher incidence of non-restorable and crown-root fracture was reported in CII+V. No predisposing factor for fracture was identified.
Conclusions: The presence of restored cervical lesion did not affect the rate of survival without fracture in premolar ETT with exposed occluso-proximal cavity and restored with resin composite.

Keywords: cervical lesion, coronal restoration, endodontically treated teeth, survival rate, tooth fracture

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Introduction

Endodontically treated teeth (ETT) are often weak and prone to fracture due to extensive loss of tooth structure [1, 2]. A post-endodontic coronal restoration not only prevents coronal leakage, but also protects the remaining tooth structure from fracture, thereby ensuring long-term success of the treatment [3, 4]. Restoration of ETT requires proper treatment planning to protect the teeth from unrestorable fracture [5].

Premolar ETT with adequate remaining tooth structure and adjacent teeth can be conservatively restored with a direct restoration [6, 7]. A randomized control trial reported that premolar ETT with two or more remaining coronal walls,

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restored with resin composite, have a high survival rate without fracture comparable to those restored with crowns [6]. Furthermore, presence of proximal contacts with adjacent teeth improves the survival rate of the ETT by distributing occlusal forces during function [7].

Loss of cervical tooth structure, known as class V cavity or cervical lesion, is induced by carious and/or non-carious (abrasion, erosion, or abfraction) causes. The cervical lesions are frequently detected in anterior teeth and premolars [8]. Finite element analysis (FEA) shows that a cervical lesion induces a high-stress concentration at the cervical area, especially at the pulpal floor of the wedge-shaped cavity [9–11]. As the depth of the cervical lesion increases, fracture resistance of the tooth gradually decreases. However, resin composite restoration is able to reverse the change in stress distribution pattern and regain the reduced strength [12, 13].

Marginal ridge loss in premolar ETT due to an exposed occluso-proximal cavity leads to decreased fractural strength [1]. A higher risk of tooth fracture is expected in the ETT with cervical lesions as the additional loss of tooth structure causes increased stress concentration at the cervical region [13]. This expectation drives practitioners to consider full-coverage crowns for ETT with additional cervical lesions. However, when the cervical lesion is restored with resin composite, the altered stress-strain pattern reverses to normal, and fracture resistance is improved [12, 13]. Therefore, a resin-composite restored cervical lesion might not alter fracture resistance and survival without fracture in ETT with exposed occluso-proximal cavity. Nonetheless, no clinical evidence has been previously reported to support this assumption.

Therefore, the purpose of this retrospective cohort study was to compare the survival rates without fracture of premolar ETT with exposed occluso-proximal cavity, in the presence or absence of additional cervical lesions restored with resin composite. Additionally, potential risk factors for ETT fracture were assessed.

Materials and methods

Materials and methods

The dental records of patients who attended the Endodontic Clinic, Faculty of Dentistry, Mahidol University, data of patients who received non-surgical endodontic treatment in the maxillary or mandibular premolars and attended recall (s) between January 2011 and June 2020 were selected. Direct resin composite restorations were provided as post-endodontic restoration in these premolars by undergraduate or postgraduate students. This retrospective cohort study was conducted with the approval from the Institutional Review Board of Faculty of Dentistry and Faculty of Pharmacy, Mahidol University (MU-DT/PY-IRB 2020/DT011), Bangkok, Thailand. The need for informed consent was waived due to the retrospective nature of the study.

Selection criteria and data collection

Premolar ETT were selected based on the following criteria. The inclusion criteria were: (1) premolar ETT with exposed occluso-proximal cavity with loss of 2–3 surfaces (mesial or/and distal surfaces), with or without the additional cervical lesion; (2) with completed root formation; (3) restored with direct resin composite; (4) with opposing natural tooth or fixed dental prosthesis; and (5) the patients attended recall sessions. The exclusion criteria were: (1) ETT with endodontic and/or restorative procedural complications that has the compromised structural integrity and strength of the tooth; (2) with crack and/or fracture in either coronal or radicular tooth structure prior to

treatment; and (3) undergoing orthodontic treatment with fixed or removable appliances, except orthodontic retainers.

Details of clinical and radiographic examinations were collected from dental charts and radiographic databases. The following data were recorded: gender, age, tooth location, number of surfaces lost in the proximal cavity, cervical lesion depth, opposing tooth, number of contacts, parafunctional habit, and crestal bone level. In ETT that fractured, information about fracture and restorability were identified.

Endodontic and restorative procedures

The endodontic treatment was performed under rubber dam isolation. After access opening, root canals were shaped by the crown-down technique using stainless steel files and/or Ni-Ti rotary files, and irrigated with 2.5% sodium hypochlorite and 17% EDTA. Calcium hydroxide was used as intracanal medication for at least 2 weeks in the majority of the cases. The root canals were obturated with gutta percha and root canal sealer [zinc oxide eugenol (MU Sealer; M Dent, Bangkok, Thailand), or epoxy resin (AH plus; Dentsply Maillefer, Tulsa, OK, USA)] using warm vertical or lateral compaction techniques. The gutta percha was seared approximately 1–3 mm below the gingival margin of the proximal cavity, and the coronal access was temporarily restored (CAVITON; GC corp., Tokyo, Japan and/or IRM® Intermediate Restorative Material; Dentsply Caulk, Delaware, USA).

All the teeth had received a post-endodontic restoration as soon as possible after the obturation. The orifice was covered with 1–2 mm thick glass-ionomer cement (GIC) liner (Vitrebond; 3M ESPE, St. Paul, MN, USA, or Fuji VII pink; GC corp., Tokyo, Japan). The cavity was bonded with a dental adhesive— etch and rinse (Adper Single Bond 2; 3M ESPE, St. Paul, MN, USA), or self-etch system (Clearfil SE Bond; Kuraray, Osaka, Japan). Micro-hybrid or nano-hybrid resin composite (Filtek Z250 or Z350; 3M ESPE) was filled incrementally in 2-mm thick layers. Each layer was light cured for 20 seconds, and 40 seconds for the top most layer. Finally, occlusion in the centric and eccentric relations was checked and adjusted before polishing the restoration.

Outcome assessment: fractured or survived

The teeth were defined as ‘fractured' or ‘survived’, for outcome assessment. Survived teeth were those present for at least 1-year post restoration without fracture.

The fracture locations were assessed, based on involved tooth structure, as ‘crown’, ‘crown-root’, or ‘root’ fracture. The restorability of the fractured teeth was classified as ‘restorable’ or ‘non-restorable’.

Statistical analysis

Statistical analysis was performed using SPSS software ver. 22.0 (IBM, Armonk, NY, USA). The survival period of premolar ETT without fracture was calculated using Kaplan-Meier survival analysis. The rates of survival without fracture of teeth having exposed occluso-proximal cavity with cervical lesion restored using resin composite (CII+V) and those without the additional cervical lesion (CII) were compared using log-rank test (α = 0.05).

The potential risk factors related to the incidence of fracture in CII and CII+V groups were statistically analyzed by Cox proportional hazard models: (1) univariate analysis was used to initially identify the possible association between the potential factors and the survival rate without fracture. A cut-off of *p*-value <.20 was decided to select the factors included in multivariate analysis; and (2) multivariate analysis was performed on the initially recognized potential factors to identify and conclude the definitive potential risk(s).

Results

From 89 patients, 102 premolar ETT with exposed occluso-proximal cavity, with or without additional cervical lesion, were included. All teeth were a single-unit restoration. There were 53 teeth in the CII group and 49 teeth in the CII+V group with 30.7±16.4 months and 34.5±15.9 months follow-up periods, respectively. Data distribution of related factors were not significantly different between the two groups except the age and the crestal bone level (Fisher Exact test, *p*-value = 0.05) (Table 1).

The overall survival rate without fracture of premolar ETT was 91.2% (93/102). Based on cavity

Table 1 Characteristics of endodontically treated premolars included in the present study according to the existence of cervical lesion (n=102 teeth).

Characteristics		CII (n=53)		CII+V (n=49)		*p*-value*
		n	%	n	%	
Patient factors						
Gender	Male	12	22.6	16	32.7	.28
	Female	41	77.4	33	67.3	
Age (years old)	Less than 50	25	47.2	12	24.5	.02
	≥ 50	28	52.8	37	75.5	
Tooth factors						
Tooth location	Maxillary teeth	32	60.4	23	46.9	.23
	Mandibular teeth	21	39.6	26	53.1	
Proximal cavity	2 surfaces loss	34	64.2	39	79.6	.12
	3 surfaces loss	19	35.8	10	20.4	
Depth of cervical lesion	Pulp exposure	-	-	6	12.2	-
	No pulp exposure	-	-	43	87.8	
Opposing tooth	Natural tooth	52	98.1	47	95.9	.60
	Fixed restoration	1	1.9	2	4.1	
Contact	2 sides	39	73.6	32	65.3	.40
	0-1 side	14	26.4	17	34.7	
Parafunctional habit	No	53	100	45	91.8	.05
	Yes	-	-	4	8.2	
Crestal bone level	Coronal	51	96.2	40	81.6	.02
	Middle	2	3.8	9	18.4	

* Fisher's exact test in each characteristic category

type, the survival rate of CII was 92.5% (49/53), and of CII+V was 89.8 (44/49). The Kaplan-Meier survival curves (Figure 1) present the cumulative survival rates of premolar ETT with exposed occluso-proximal cavity and restored with resin composite restorations, according to the presence or absence of additional cervical lesion. The log-rank analysis did not show any significant difference in the survival rates between the CII and CII+V groups (p-value ≥ 0.5).

Totally, the nine fractured ETT were evaluated for fracture locations and restorability. In the CII group, the fracture locations of ETT were crown fracture (n=2, 50%) and crown-root fracture (n=2, 50%). The two fractured ETT (50%) in the CII group were non-restorable. In the CII+V group, the fracture location of ETT were crown fracture (n=1, 20%) and crown-root fracture (n=4, 80%). The three fractured ETT (60%) in the CII+V group were non-restorable.

The survival rates and univariate analysis are shown in Table 2. The three related factors— cervical lesion depth, opposing tooth, and parafunctional habit were excluded before univariate analysis since the numbers of ETT and/or incidences of fracture in their subcategories were not sufficient for statistical analysis. None of the remaining factors showed a significant effect on the survival rate without fracture of premolar ETT with exposed occluso-proximal cavity, regardless of additional cervical lesion (p-value ≥ 0.5). The multivariate Cox proportional hazards model could not be performed since all factors had p-values higher than the cut-off level at .20 in the univariate analysis.

Discussion

In the present study, the effect of an additional cervical lesion on the rate of survival without fracture of premolar ETT with exposed occluso-proximal cavity and restored with resin composite was investigated. An overall survival rate of 91.2% in premolar ETT up to the 5-year recall period demonstrated good long-term prognosis when resin composite was used for post-endodontic restoration. The conservative approach of resin composite restoration in ETT has the added benefits of cost-effectiveness and reduced chair time.

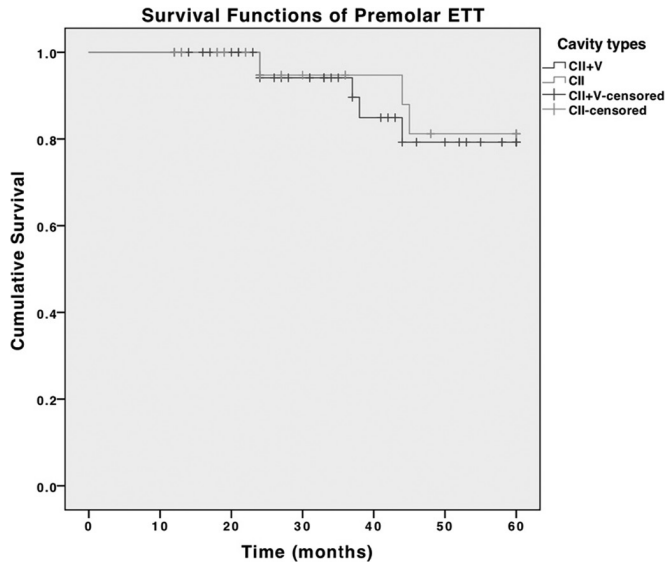

Figure 1 The Kaplan-Meier cumulative survival curves of premolar ETT with exposed proximal cavity with or without cervical lesion restored with resin composite. The log-rank test did not show any significant difference in the rate of survival without fracture between premolar ETT with presence or absence of cervical lesion (p-value ≥.05).

Table 2 Cumulative survival rate and univariate analysis of endodontically treated premolars according to the related factors in the present study (n = 102 teeth).

Factors*		Number of teeth	Survived without fracture n (%)	With fracture n (%)	*p*-value
Cavity type	Class II	53	49 (92.5%)	4 (7.5%)	.79
	Class II+V	49	44 (89.8%)	5 (10.2%)	
Gender	Male	28	25 (89.3%)	3 (10.7%)	.84
	Female	74	68 (91.9%)	6 (8.1%)	
Age (years old)	Less than 50	37	35 (94.6%)	2 (5.4%)	.47
	≥ 50	65	58 (89.2%)	5 (10.8%)	
Tooth location	Maxillary teeth	55	51 (92.7%)	4 (7.3%)	.31
	Mandibular	47	42 (89.4%)	5 (10.6%)	
Proximal cavity	2 surfaces loss	73	66 (90.4%)	7 (9.6%)	.58
	3 surfaces loss	29	27 (93.1%)	2 (6.9%)	
Contact	2 sides	71	64 (90.1%)	7 (9.9%)	.67
	0-1 side	31	29 (93.5%)	2 (6.5%)	
Crestal bone level	Coronal	91	84 (92.3%)	7 (7.7%)	.55
	Middle	11	9 (81.8%)	2 (18.2%)	

* The three factors- cervical lesion depth, opposing tooth, and parafunctional habit were excluded before univariate analysis since the number of teeth and/or incidence of fracture in their subcategories were not sufficient for statistical analysis.

A comparable survival rate between the CII and CII+V groups, in the results, demonstrated that the presence of a restored cervical lesion did not negatively affect the survival without fracture of ETT. From laboratory-based studies, the altered stress-strain pattern, and the reduced strength of the tooth with cervical lesion is reversed with a bonded restoration [9, 10, 12, 13]. Furthermore, resin composite has a modulus of elasticity close to dentin more than other restorative materials such as amalgam or glass-ionomer and may create the “monoblock” that enhances fracture resistance of ETT [14]. Additionally, the depth and the size of the cervical lesion are related to the fracture resistance of the tooth [9]. As most of the cervical lesions in the present study were small to moderate in size and depth, the presence of cervical cavities did not clinically affect the survival of premolar ETT with exposed occluso-proximal cavities.

The amount of remaining tooth structure is significant to fracture resistance and survival of ETT [7, 15–17]. In the present study, the survival rate of the CII group is consistent with the results from previous studies that reported a favorable survival rate in premolar ETT having moderate loss of tooth structure restored with resin composite [7, 16]. In our study, only premolar ETT with two or three surfaces of proximal cavity were included. However, there were only few cases with three-

surface cavity that were included since the majority of them received a crown restoration. Therefore, the samples in this study were mostly two-surface cavity, which still had enough remaining tooth structure for the conservative restorative approach. Furthermore, most of the ETT had two proximal contacts, and parafunctional habits were absent. These positive conditions tend to improve the survival rate of premolar ETT [7, 18, 19]. Therefore, clinical application of our results as generalized to premolar ETT with different conditions must be cautioned.

Regarding fracture location and restorability, the CII group had equal incidence of crown (50%) and crown-root fracture (50%), whilst crown-root fracture (80%) was the predominant fracture location in the CII+V group. When the cervical tooth loss extended onto the root structure, the fracture more commonly involved both cervical and proximal structures and was identified as crown-root fracture, as in the CII+V group. Nonetheless, the cervical fracture often involved the root structure above the gingival level. Thus, the remaining tooth structure after fracture still had an adequate 'ferrule' to support a new restoration. Therefore, the number of restorable fractures were comparable between the CII and CII+V groups, despite the differences in fracture location.

In the present study, no risk factors related to fracture were identified. The high survival rates of premolar ETT in this study might be attributed to the positive conditions of several factors (such as moderate loss of tooth structure), as previously mentioned. Additionally, the number of fractured ETT was limited (only four teeth in the CII group and five teeth in the CII+V group [9]. Hence, the low incidence of fracture could have limited the ability of the study to identify any risk factors.

Due to the nature of the retrospective study, the available data were limited by the information recorded in patient's charts and radiographs. For this concern, the present study was unable to identify the type of resin composite used, so the effect of resin composite types on the survival from fracture of the ETTs could not be concluded. The absence or presence of posterior tooth support also could not be identified. This was the limitation of the retrospective study.

The rate of survival without fracture of premolar ETT with exposed occluso-proximal cavity was not affected by an additional cervical lesion when restored with resin composite. Moreover, the high survival rate of the premolar ETT, with moderate loss of tooth structure and two proximal contacts, restored with resin composite enhances the concept of conservative restoration; direct restoration could be successfully performed in such specific cases [20]. Further prospective studies including randomized control trials need to be conducted to confirm these clinical findings.

Conclusion

In this retrospective study, the presence of an additional cervical lesion showed no effect to the rate of survival rate without fracture in premolar ETT with exposed occluso-proximal cavity, when restored with resin composite. The post-endodontic restoration in these premolar ETT should be based on the existing management guidelines for ETT with exposed occluso-proximal cavity.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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