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EVALUATE THE ORTHODONTIC ROOT RESORPTION AFTER ENDODONTIC TREATMENT: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Abstract

Background and aim: the present study was conducted with the aim of evaluating the orthodontic root resorption after endodontic treatment.

Method: The present study was conducted based on PRISMA 2020-27-item checklist. To find the studies conducted in line with the purpose of the study, PubMed, Web of Science, Scopus, Science Direct, Web of Knowledge, EBSCO, Wiley, ISI, Elsevier, Embase databases and Google Scholar search engine were reviewed from 2013 to August 2023. Meta-analysis was performed using mean differences with 95% confidence interval. The publication bias was checked by Egger test and funnel plot, data analysis was done using STATA/MP. v17 software.

Result: six articles with 418 patients with 515 teeth were examined. Mean differences of orthodontic root resorption between root-filled teeth and vital pulp teeth was 0.45 (MD: 0.45 95% CI 0.30, 0.61; $p < 0.01$).

Conclusion: Root-filled teeth can significantly reduce orthodontic root resorption after orthodontic treatment.

Key words: Orthodontic Root Resorption, Endodontic Treatment, Orthodontic Treatment

Introduction

A thin anti-resorptive barrier protects the internal and external walls of the tooth roots. The pre-cementum layer protects the external walls, while predentin and odontoblasts protect the inner walls of the tooth dentin(1). Resorption is associated with physiological and pathological factors and results in the loss of dentin, cement, or bone tissues.³ Resorptive cells cannot colonize nonmineralized surfaces. Multiple mechanical, chemical, and thermal factors have been established that encourage early mineralization of defensive barriers and initiate root resorption(2). Orthodontic root resorption is one of the common and undesirable consequences caused by inflammation and tooth movement(3).

Evidence shows that about 90% of orthodontic root resorption occurs during orthodontic movement(4). The findings of the studies indicate that root erosion of more than 1 mm occurs in about 80 percent and above in patients undergoing orthodontic treatment, and about 50 percent have reported root erosion of more than 3 mm(5-7). The findings of a study also reported that after orthodontic treatment, about 14.8% of severe root resorption was observed(8). During orthodontic treatment, one should be very careful about root resorption because it is considered one of the important consequences of orthodontic treatment and can affect the longevity of the teeth and reduce the results of the treatment(9).

Many factors can affect orthodontic root resorption, including the duration of orthodontic treatment, the age of the patient, the type of devices used in orthodontics, and the amount of orthodontic force(3, 6, 10). Also, the findings of some studies have shown that pulp condition and previous endodontic treatment can be

related to orthodontic root resorption(11-13).

Evidence shows that teeth treated with orthodontics may require root canal treatment, however, the possibility of root resorption after orthodontic movement is challenging(14). Therefore, the present study was conducted with the aim of evaluating the orthodontic root resorption after endodontic treatment.

Method

Search strategy and Information sources

The present study was conducted based on PRISMA 2020-27-item checklist(15). The reviewed documents were the results of the search in the international databases PubMed, Web of Science, Scopus, Science Direct, Web of Knowledge, EBSCO, Wiley, ISI, Elsevier, Embase databases and Google Scholar search engine, the search was limited to 10 years. Recent and updated up to August 2023 were among the articles published in English.

Searching in the mentioned databases, Keywords “endodontic”, ““root resorption”, “root canal treatment”, “Orthodontic root resorptio” were used to search the mentioned databases. The keywords were standardized in MeSH and finally, the strategy with (((("Root Canal Obturation"[Mesh]) OR "Dental Implantation, Endosseous, Endodontic"[Mesh]) OR ("Dental Pulp Cavity"[Mesh] OR "Root Canal Therapy"[Mesh] OR "Root Canal Irrigants"[Mesh])) AND "Root Resorption"[Mesh]) OR ("Root Resorption/prevention and control"[Mesh] OR "Root Resorption/therapy"[Mesh])) AND ("Orthodontic Appliances, Fixed"[Mesh] OR "Index of Orthodontic Treatment Need"[Mesh] OR "Orthodontic Anchorage Procedures"[Mesh] OR "Orthodontic Retainers"[Mesh] OR

"Orthodontic Brackets"[Mesh] OR
 "Orthodontic Extrusion"[Mesh] OR
 "Orthodontic Wires"[Mesh] OR
 "Orthodontic Appliances,
 Removable"[Mesh] OR "Orthodontic
 Appliances"[Mesh] OR "Dental
 Cements"[Mesh]) keywords was used for
 searching. In addition to this list of sources,
 the selected articles were screened to find
 relevant references. To avoid bias, the
 search was done by two researchers
 independently.

Study selection criteria

Inclusion criteria

Imaging techniques, RCT studies, cohort studies, root resorption outcomes, outcome before and after orthodontic treatment and availability of the full text of the article. studies with incomplete results; case studies; case reports studies; in vitro, in vivo studies and review articles were excluded.

Selection and data collection process

To reduce reporting bias and errors in data collection, two researchers independently extracted data from the articles using a standard data collection form that had been prepared in advance. This form was first designed by the study team, which included the following items: author's name, year of publication, average age of patients, number of teeth, type of teeth, time and type of treatment and number of patients.

Study risk of bias assessment

The Newcastle-Ottawa Scale (NOS) for assessing the quality of non-randomized studies in meta-analyses. Studies are graded one point each for all items except comparability which has the potential to score up to two points, with the maximum possible score being nine. Studies are rated from 0–9, with those studies rating 0–2 (poor quality), 3–5 (fair quality), 6–9 (good/high quality)(16).

Cochrane risk-of-bias tool for randomized trials (RoB 2) is the recommended tool to assess the risk of bias in randomized trials.

Data analysis

Meta-analysis was performed using mean differences with 95% confidence interval. To estimate the heterogeneity of the studies, the index I^2 (<25%: weak heterogeneity, 25-75%: moderate heterogeneity, and more than 75%: high heterogeneity) was used. The results were combined using the fixed effect model (Inverse-variance method) in meta-analysis. The publication bias was checked by Egger test and Beggs funnel plot and data analysis was done using STATA/MP. v17 software. A p-value of less than 0.05 was considered significant.

Result

Study selection

First, a search was conducted with relevant keywords, and then a list of titles and abstracts of all articles searched in international databases was prepared. This work was done independently by two researchers. Then the articles were entered into EndNote.X8 software and articles with duplicate titles were removed (31 articles). In the following, the abstract of 172 articles was reviewed to find suitable studies, and the articles that met the exclusion criteria and did not meet the inclusion criteria were excluded at this stage. The full text of 34 articles was carefully reviewed by two researchers independently and blindly, and the third researcher reviewed the selected articles until consensus was reached. At this stage, articles with duplicate data, incomplete data, failure to meet the inclusion criteria were removed, and at the end, six articles were selected for analysis (meta-analysis) (Fig.1).

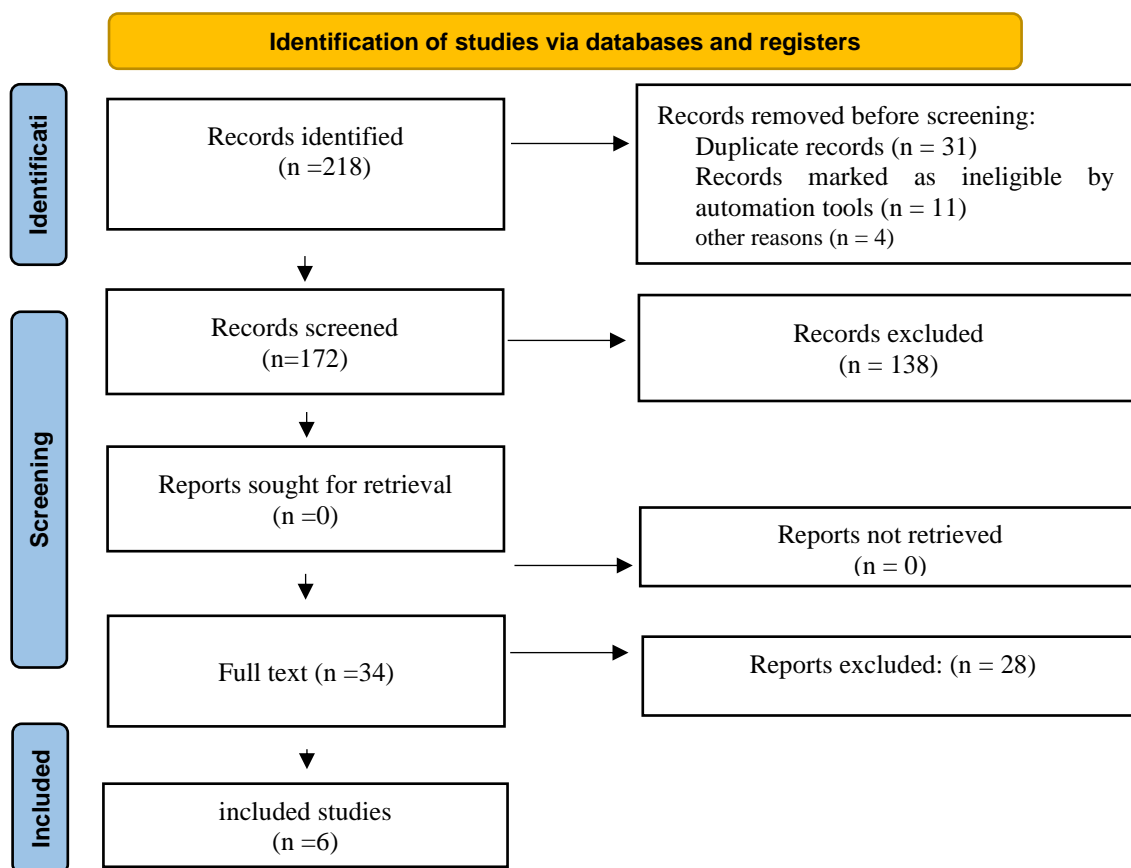


Figure 1. PRISMA 2020 Checklist.

Study characteristics

418 patients (female: 245; male: 173) with 515 teeth were examined. A summary of

the demographic data of the studies is summarized in Table 1.

Table 1. Summary characteristics of studies.

No.	Study. Years	Study design	Number of Patients		Teeth		mean of age	Treatment	
			female	male	Number	Type			Time (months)
1	Şeker et al., 2023 (17)	Ret	110	63	346	1.Maxillary premolar (35) 2.Mandibular premolar (20) 3.Mandibular molars (113) 4. Maxillary central (11)	18.78 ± 3.55	1. With extraction (43) 2. no extraction (130)	27

						5. Maxillary molars (54)			
2	Kurnaz et al., 2021 (18)	Ret	19	15	34	Mandibular molars	17.72 ± 2.78	Brackets	24
		Ret	18	17	35	Mandibular molars	18.16 ± 3.79	Brackets	18
3	Khan et al., 2018 (19)	Ret	13	17	30	Not reported	26.37 ± 2.4	NR	36
4	Yanli et al., 2017 (20)	Ret	30	30	60	Not reported	12-38	Straight-wire technique	12-18
5	Lee et al.,2016 (21)	Ret	35	27	8	Not reported	25.23 ± 4.92	Multiple	26
6	Castro et al., 2015 (22)	Ret	20	4	2	Posterior teeth	12.8 ± 1.8	Straight-wire technique	22

Ret: Retrospective

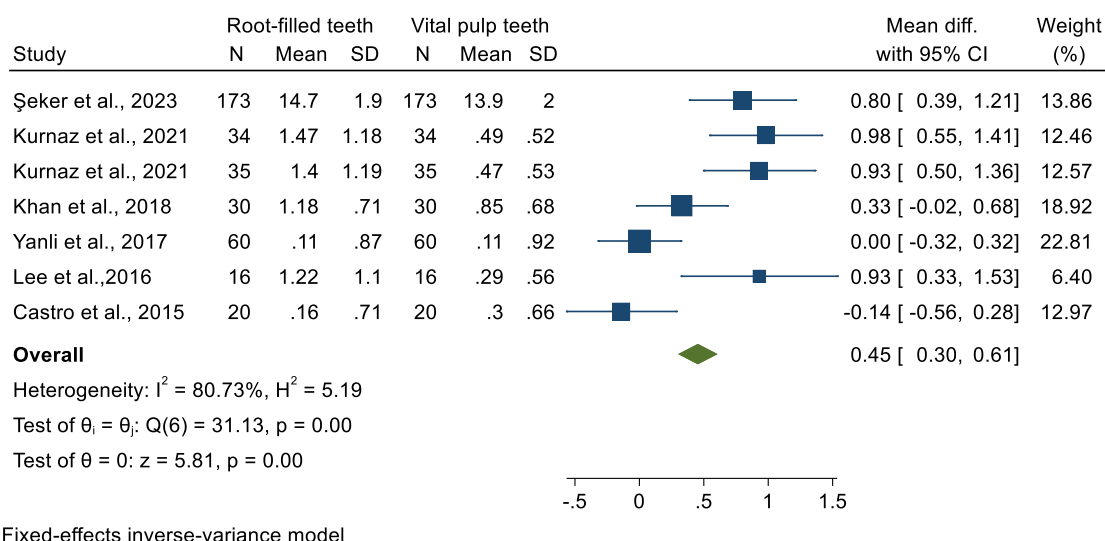


Figure 2. Forest plot showed mean differences of orthodontic root resorption between root-filled teeth and vital pulp teeth.

Mean differences of orthodontic root resorption between root-filled teeth and

vital pulp teeth was 0.45 (MD: 0.45 95% CI 0.30, 0.61; $p < 0.01$). meta-analysis showed

orthodontic root resorption of root-filled teeth was significantly lower than that of vital pulp teeth ($p < 0.01$) (Figure 2).

High heterogeneity observed between studies ($I^2 = 80.73\%$; $p < 0.01$).

According to the funnel plot (Figure 3), publication bias was observed in some

selected studies. As can be seen, the funnel plot shows an asymmetric result, which indicates the presence of diffusion bias. Egger's test also confirms the results of the funnel design ($p < 0.05$).

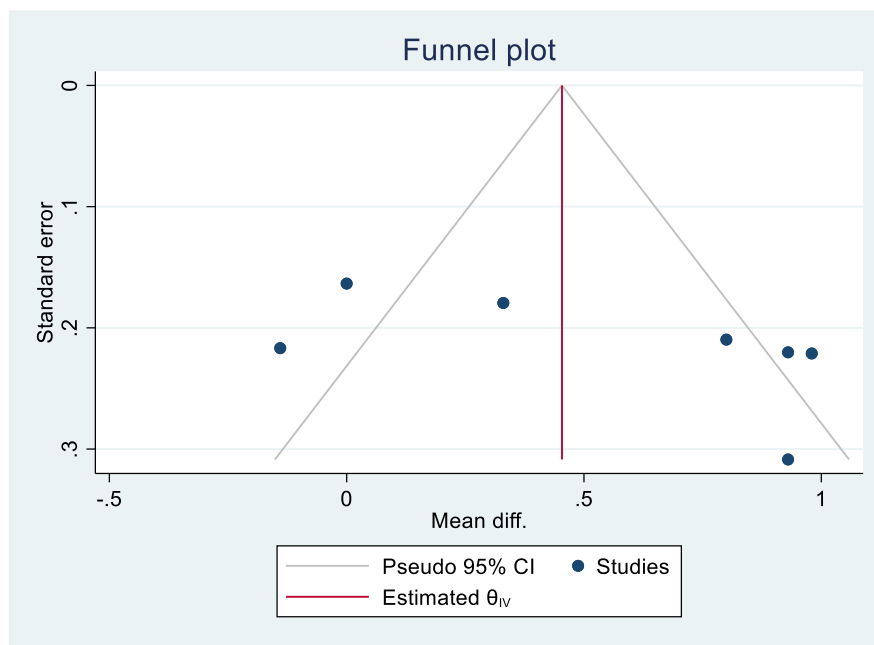


Figure 3. Funnel plot showed publication bias of studies

Discussion

The present meta-analysis showed that orthodontic root resorption in root-filled teeth was significantly lower compared to vital pulp teeth; These findings are consistent with the results of previous studies(23, 24). Zhao et al. (2023) reported findings similar to the present results. In their study, by examining Orthodontic Treatment under Endodontic Consideration Based on Orthodontic Root Resorption, it was observed that orthodontic root resorption in the endodontically treated group was significantly lower than vital pulp teeth(25).

A study in a rat model has shown that the risk of inflammatory root resorption can be affected by orthodontic light forces, however, evidence to confirm these findings is not available(26). Another study also reported that inflammatory cytokines

and damaged and stretched pulp cells initiate odontoclastic activity, pulp tissue changes can increase orthodontic root resorption in vital pulp(27). As stated, a high heterogeneity was found between the studies, which indicates that the results of the present study should be interpreted with caution, and more studies are needed to confirm the evidence and differences observed between root-filled teeth and vital pulp teeth. The reason for the high heterogeneity can be related to the difference in the cognitive method, how to

evaluate the results, and the imaging techniques used, so future studies should use a similar cognitive method to reduce bias. Also, special attention should be paid to the factors involved in orthodontic root resorption, such as the age of patients, the time of orthodontic treatment. Based on the

findings of the studies, the position of the teeth can be related to the increase in orthodontic root resorption; However, there is no strong evidence to confirm these results; Most studies have stated that orthodontic root resorption in posterior teeth is less than anterior teeth(5, 28).

Studies have also investigated the incidence and severity of orthodontic root resorption, and the findings indicate that the use of fixed orthodontic appliances increases the incidence and severity of orthodontic root resorption compared to clear aligners(29, 30). These findings are not supported by sufficient evidence and more comprehensive studies are needed. Until now, there is no clear conclusion about the time of orthodontic treatment after root treatment, a study has shown that orthodontic root resorption for root-filled teeth is related to the healing degree of periapical lesions after root treatment(26). A study reported that if significant periapical radiolucency is present, orthodontic treatment should be delayed for at least six months until radiographic evidence of healing is obtained(31). Another study has shown that orthodontics for teeth with moderate damage should be done one year later so that the periapical radiograph and/or tomography is normal, and if the damage is more severe, this period will be two years(32).

It is suggested that six months after the start of orthodontic treatment, clinical monitoring and X-rays should be done in order to get enough information about the treatment process. Teeth that have undergone root canal treatment due to trauma should have comprehensive imaging findings before starting orthodontic treatment.

The current study has limitations, such as the sample size of the studies was very

small and the imaging techniques were different in the studies, it is necessary to conduct studies with a higher sample size and similar imaging techniques. Interval between treatments was not reported for all the selected studies and one year was reported only for the study of Kurnaz et al., 2021. No randomized controlled trials were found, and all the studies were done retrospectively, and due to the high heterogeneity between the studies, the results of the present study should be interpreted with caution. Higher quality clinical data, control of confounding factors as much as possible and assessment with CBCT are needed.

Conclusion

Root-filled teeth can significantly reduce orthodontic root resorption after orthodontic treatment, it should be noted that root treatment should be done first when both root and orthodontic treatment are needed. It is better to pay attention to the radiographic findings before starting orthodontic treatment and show the normal periapical radiograph results.

Investigating the relationship between factors affecting orthodontic root resorption should be comprehensively investigated in future studies, it is also suggested to investigate the effect of periapical infection and the size of apical radiolucency on orthodontic root resorption.

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