

# Single versus Multiple Visits Endodontic Therapy on Healing Rate of Periapical Lesions: A Systematic Review and Meta-analysis

## SUMMARY

*The choice of one or more sessions for the endodontic treatment of teeth with pulp necrosis and apical periodontitis is controversial. The purpose of this systematic review was to compare the radiographic healing of necrotic teeth with pre-existing periapical lesions after at least 1 year of follow-up period between two therapy groups: 1. single visit endodontic treatment, 2. multiple visits endodontic treatment with calcium hydroxide as intracanal medicament. It was made a literature search of only Randomized Controlled Trials (RCTs) on PubMed database. 5 RCTs met the inclusion and exclusion criteria and were included in this review, with a total sample size of 513 cases. Complete radiographic healing was observed in 226 (83.4%) of 271 cases treated in one visit and 198 (81.8%) of 242 cases treated in more than one visit. A meta-analysis was performed, showing no significant difference in the healing rate between the two therapy groups (fixed effect model, RR: 1.025; 95% CI: 0.950 – 1.107). Based on the results of this study, endodontic treatment of teeth with pulp necrosis and radiographic evidence of apical periodontitis in one or more appointments showed similar radiographic healing rate.*

**Keywords:** Apical Periodontitis, Calcium Hydroxide, Meta-analysis, Periapical Healing, Single Visit Endodontic Therapy, Systematic Review

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## Introduction

Apical periodontitis is an inflammatory disease caused by bacteria colonizing the necrotic root canal system<sup>1-5</sup>. It is the outcome of the host defence response to the bacteria and their byproducts, which leads to local inflammation and the consequent resorption of hard tissues, destruction of periradicular tissues and formation of periapical lesions. Radiographically interpreted lesions are used to assess periapical inflammation<sup>4-12</sup>.

The process of healing depends on the structural and functional replacement of the affected areas<sup>9-11,13,14</sup>. Biological purpose of the endodontic therapy is to eliminate the microbial load as much as possible, allowing chronic inflammatory tissue to become reparative tissue. Periapical healing can be radiographically observable<sup>5,9,13</sup>.

The success of the endodontic therapy depends on the proper chemo-mechanical preparation and three

dimensional obturation of the root canal system<sup>13,15-19</sup>. A final restoration is also essential, in order to prevent further infection and to restore functionality<sup>20-22</sup>. The evolution of technology and the improvement of dental materials (rotary instruments, apex locators, electronic handpieces, digital radiography) have reduced treatment time and improved outcomes<sup>23,24</sup>.

Traditionally, endodontic therapy was performed in multiple visits over a period of several weeks. However, endodontic therapy in one session becomes an increasingly popular option. Advantages of single visit endodontic therapy are the time saving for both the clinician and patient and the reduced cost resulting from less chair side time and fewer materials. Multiple visits option is preferred if the patient has anxiety or discomfort during the procedure or if the available operation time is not enough. Nevertheless, the most important success

factor in the comparison of the two therapy options is the healing rate<sup>25-28</sup>.

The main difference in the procedure of single visit and multiple visits root canal treatment is the use of intracanal medication during the interappointment period. Calcium hydroxide (Ca(OH)<sub>2</sub>) is the most common intracanal medicament used. Calcium hydroxide is a strong alkaline substance used as an extra disinfecting agent besides the irrigating solution<sup>29-32</sup>. However, calcium hydroxide efficacy remains unclear<sup>33-39</sup>. Single visit approach aims that the obturation of the root canal system directly after the chemo-mechanical preparation entombs the remaining bacteria and limits the offered space and nutrition<sup>32, 40-42</sup>.

Studies have been done that compare single visit root canal treatment and multiple visits root canal treatment due to long-term outcomes and short term outcomes (post-operative pain, analgesic use, incidence of flare-up or swelling)<sup>43-54</sup>. Aim of this systematic review is to compare the healing rate of single visit endodontic therapy and multiple visits endodontic therapy of teeth with radiographic evidence of apical periodontitis. In order for this to happen, strict criteria must be set to ensure that the procedures followed in the included studies are based on a common strategy. Randomized controlled trials (RCTs) are considered the highest level of evidence in the hierarchy of research designs<sup>55</sup>.

## Material and Methods

### Search Strategy

It was made an advanced search of Randomized Controlled Trials (RCTs) until May 30, 2023 in the PubMed/MEDLINE. The search query used is: (single OR one) AND (multi OR multiple OR two OR three) AND (visit OR visits OR session OR sessions OR appointment OR appointments) AND (endodontic therapy OR endodontic treatment OR root canal therapy OR root canal treatment OR pulpectomy OR pulpotomy). "Randomized Controlled Trial" was selected in the "ARTICLE TYPE" filter option.

### Inclusion Criteria

1. Randomized Controlled Trials
2. Sample of the RCTs contains permanent teeth with diagnosis of pulp necrosis and demonstrable periapical radiolucent lesion
3. The purpose of the RCT is to compare the outcome of endodontic therapy performed at a single visit or multiple visits
4. The outcome of the investigation is the radiographic evidence of periapical healing

5. Calcium Hydroxide is used as intracanal medication in the interappointment period of multiple visits endodontic therapy

### Exclusion Criteria

1. Non Randomized Controlled Trials
2. Studies that do not compare single visit and multiple visits endodontic therapy due to the outcome of radiographic evidence of complete periapical healing
3. RCTs with a sample that contains primary teeth or permanent teeth with incomplete apical formation
4. RCTs with a sample that contains teeth with vital pulp or teeth with necrotic pulp and no periapical radiolucent lesion or teeth with undefined pulp condition
5. Endodontic retreatment cases or surgical endodontic treatment cases
6. Use of root canal irrigants other than sodium hypochlorite and EDTA
7. Radiographic follow-up < 1 year
8. No healing rate presented

### Statistical Analysis

The statistical unit is the tooth. The main outcome measured in this systematic review is the radiographic success after at least 1 year of follow-up (binary: healed/not healed). If the radiographic result is uncertain then it is mentioned as not healed. The main purpose of this systematic review is to ensure that the included Randomized Controlled Trials follow a similar design. If a study compares the radiographic outcome between 3 groups (1. Single visit endodontic therapy, 2. Multiple visits endodontic therapy with no use of intracanal medication, 3. Multiple visits endodontic therapy with use of Calcium Hydroxide as intracanal medication), then the groups that do not use intracanal medication in the interappointment period are excluded from the results of this systematic review.

Relative risk (RR) and its respective 95% confidence interval (CI) were calculated for each study. Heterogeneity was assessed using Cochran's Q test and I<sup>2</sup> statistics. A random effect model is applied when the heterogeneity is significant (I<sup>2</sup> > 50%, P < 0.1). A fixed effect model is applied when the heterogeneity is low or moderate (I<sup>2</sup> < 50%, P > 0.1). Egger's test and Funnel plot were used to investigate publication bias or small study effects. The statistical software used is MedCalc software.

## Results

### Included and excluded studies

165 RCTs were identified using the advanced search of PubMed database, while 28 were selected for reading the abstracts. We have read 14 studies fully<sup>56-69</sup>. The

inclusion and exclusion criteria eliminated 5 studies<sup>56-60</sup>. Five studies of the systematic review and meta-analysis are: Trope *et al.* (1999), Peters and Wesselink (2002), Molander *et al.* (2007), Penesis *et al.* (2008), Paredes-Vieira and Enriquez (2012). Nine studies excluded from the systematic review and meta-analysis are summarized at Table 1.<sup>61-69</sup>

Table 1: Excluded studies

Excluded Studies	Exclusion Criteria
Fava (1994)	2
Prashanth <i>et al.</i> (2011)	7
Wong <i>et al.</i> (2015)	4
DeCastro <i>et al.</i> (2016)	2
Fonzar <i>et al.</i> (2017)	4
Kurt and Çalışkan (2018)	6
Xavier <i>et al.</i> (2022)	2.6
Karaođlan <i>et al.</i> (2022)	5
Kurt <i>et al.</i> (2022)	6

### Analysis of the overall sample

The 5 RCTs included in the systematic review consist of a total of 513 teeth, with 271 teeth treated in a single visit and 242 teeth treated in multiple visits with calcium hydroxide (Ca(OH)<sub>2</sub>) as intracanal medicament. Table 2. summarizes the characteristics of the included studies.

### Radiographic evidence of apical periodontitis

Out of the 5 RCTs, 3 RCTs involve the size of the periapical lesion as inclusion criteria. In particular, the minimum size of the periapical lesion accepted by Penesis *et al.* (2008)<sup>59</sup> and Paredes-Vieira and Enriquez (2012)<sup>60</sup> is 2.0mm × 2.0mm, the minimum diameter of the periapical lesion accepted by Peters and Wesselink (2002)<sup>57</sup> is 0.5mm. Molander *et al.* (2007)<sup>58</sup> consider the size of the periapical lesion in the randomization process but do not involve a minimum size of it as inclusion criteria. Trope *et al.* (1999)<sup>56</sup> do not measure the size of the periapical lesion, but classify the sample of the teeth by PAI score. Therefore, it has been chosen only the sample of the teeth that had a PAI >3 at the baseline of the clinical trial in this systematic review.

### Endodontic therapy process

Two of the RCTs use only manual instrumentation<sup>56,57</sup>, while 3 RCTs use both manual and rotary instrumentation

<sup>58-60</sup>. The Concentration of the irrigant: Sodium hypochlorite range from 0.50 to 5.25%. Paredes-Vieira and Enriquez (2012)<sup>60</sup> is the only RCT that use 17% EDTA as an irrigant except Sodium hypochlorite. The inter-appointment period range from 1 to 4 weeks. Lateral obturation technique was used in all RCTs. The follow-up period range from 1 to 4.5 years.

### Outcome measure

The radiographic evidence of periapical healing is the common outcome measured. However, three scoring systems for radiographic assessment of apical periodontitis are used in the overall sample of the 5 included RCTs. The Periapical Index (PAI) Scoring System by Ørstavik (1986)<sup>70</sup> is used by Trope *et al.* (1999)<sup>56</sup>, Penesis *et al.* (2008)<sup>59</sup>, Paredes-Vieira and Enriquez (2012)<sup>60</sup>. Strindberg's radiographic criteria (1956)<sup>71</sup> are used by Molander *et al.* (2007)<sup>58</sup> and Paredes-Vieira and Enriquez (2012)<sup>60</sup>. The Probability Index (PRI) by Reit and Grondahl (1983)<sup>72</sup> is used by Peters and Wesselink (2002)<sup>57</sup>. RCTs that use PAI scoring system consider an endodontic therapy as successful if PAI: 1 or 2. RCTs that use Strindberg's radiographic criteria consider an endodontic therapy as a failure if the radiographic outcome is uncertain. Peters and Wesselink (2002)<sup>57</sup> consider an endodontic therapy as successful if PRI: 1 or 2.

### Statistical analysis

A fixed effect model is applied as the heterogeneity is moderate (I<sup>2</sup>: 25.92% < 50%, P: 0.2487 > 0.1) (Table 3, Figure 1). There is no statistical difference between the two therapy groups (RR: 1.025; 95% CI: 0,950 - 1,107). However, the study with the greatest Weight (fixed: 86.39%): Paredes-Vieira and Enriquez (2012)<sup>60</sup> is the only study that identifies a statistical difference in favour of the endodontic therapy in a single visit. The type of instrumentation used and the concentration of sodium hypochlorite appeared to have no effect on the outcome. The follow-up period seems to affect the outcome measured, as RCTs with longer follow-up period (≥2 years) exhibit an increased percentage of radiographic evidence of periapical healing and produce results in favour of single visit endodontic therapy. The Egger's test (P: 0.1805) and the analysis of the Funnel plot showed no evidence of publication bias (Figure 2).

Table 2: Included studies characteristics

Author (year)	N. analysed teeth	Instr.	NaOCl (%)	17% EDTA Yes/No (min)	Calcium Hydroxide medicament (weeks)	Obtur.	Follow-up period (years)
Trope <i>et al.</i> (1999)	41	Manual	2.50	No	1	Lateral	1
Peters and Wesselink (2002)	38	Manual	2.00	No	4	Lateral	4.50
Molander <i>et al.</i> (2007)	89	Manual and rotary	0.50	No	1	Lateral	1
Penesis <i>et al.</i> (2008)	63	Manual and rotary	5.25	No	2-4	Lateral	1
Paredes-Vieira and Enriquez (2012)	282	Manual and rotary	5.25	Yes (0.50)	1 (at least)	Lateral	2

Table 3: Studies results and meta-analysis

Author (year)	Single visit	Multiple visits	RR	95% CI	Weight (%)	
					Fixed	Random
<b>Trope et al. (1999)</b>	14/22	14/19	0.864	0.570 – 1.307	2.23	7.61
<b>Peters and Wesselink (2002)</b>	17/21	12/17	1.147	0.792 – 1.661	2.79	9.28
<b>Molander et al. (2007)</b>	32/49	30/40	0.871	0.664 – 1.142	5.20	15.48
<b>Penesis et al. (2008)</b>	22/33	21/30	0.952	0.680 – 1.333	3.39	10.95
<b>Paredes-Vieira and Enriquez (2012)</b>	141/146	121/136	1.085	1.016 – 1.160	86.39	56.68
Total (fixed effects)	226/271	198/242	1.025	0.950 – 1.107	100.00	100.00
Total (random effects)	226/271	198/242	1.022	0.905 – 1.153	100.00	100.00

Test for heterogeneity: Significance level P: 0.2487, I<sup>2</sup> (inconsistency): 25.92%

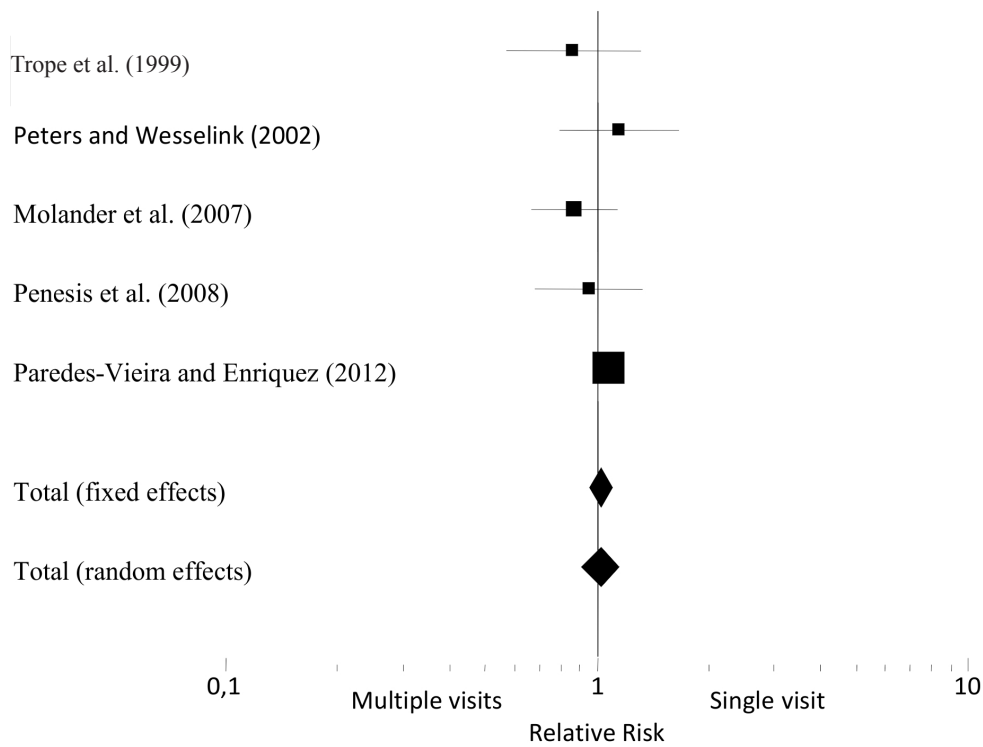


Figure 1: Forest plot

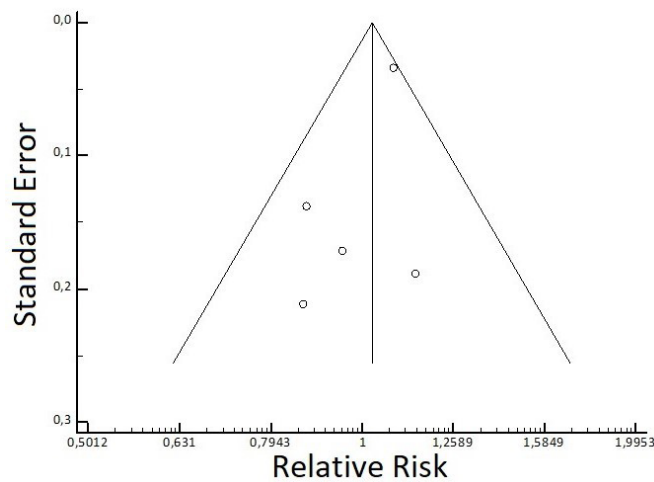


Figure 2: Funnel plot

## Discussion

This systematic review compares the radiographic outcome of endodontic therapy of teeth with radiographic evidence of apical periodontitis in one or more sessions. However, the choice of a single visit or multiple visits therapy depends on several factors, such as: the sufficiency of the operating time, the patient's cooperation, the difficulty level of the operation, the preoperative condition of the tooth, etc. The complex root canal anatomy is a factor that can reduce the success rate of an endodontic therapy and increase the operation duration<sup>41,73-78</sup>. Molars with complex root canal anatomy are more possible to get treated in more than one session. Furthermore, teeth with vital pulp have a better prognosis compared to teeth with necrotic pulp and periapical radiolucency<sup>11,15</sup>. In addition the size of the periapical lesion affects the success rate of the endodontic treatment<sup>9,10</sup>.

The sample of the systematic review has chosen to consist only of Randomized Controlled Trials, in order to eliminate the risk of selection bias, as the clinician cannot choose treatment in one or more sessions depending on the preoperative status of the teeth or intraoperative decision. Except that, it has been chosen as a requirement for the sample of multiple visits endodontic therapy only cases with demonstrable periapical radiolucent lesions and cases in which calcium hydroxide was used as an intracanal medicament. In this way, the results of the meta-analysis are based on the well-defined protocol of randomization, cases selection and treatment strategy.

The meta-analysis of the 5 RCTs included found no statistical relation between the two therapy groups. These results are in agreement with other meta-analyses<sup>44,46,47,51,52</sup>. However, the results in the RCTs with radiographic follow-up time more than 2 years show an overall greater healing rate and a higher success rate in the group of one-visit endodontic therapy.

The comparison between endodontic therapy in one or more visits can be about both long term or short term complications. Long term factors that mention the success of the endodontic therapy are: the retention of the tooth<sup>63,65</sup>, the absence of clinical symptoms, the absence of radiographic evidence of periapical pathology and healing of sinus tract or fistula. Short term factors that can be used to compare the two therapy methods are the frequency or magnitude or duration of postoperative pain, swelling or flare-up, the need of analgesic use<sup>48,79-85</sup>. Controlled trials and Systematic reviews<sup>43-46,48-52</sup> have been made comparing endodontic therapy in one or more visits based on these factors.

Calcium hydroxide is commonly used as an intracanal medicament in multiple visits endodontic treatment<sup>29-32</sup>. Studies have shown that calcium hydroxide is not very effective on reducing postoperative pain when it is used alone, but its effectiveness can be

increased in combination with other medicaments such as chlorhexidine and camphorated monochlorophenol (CMCP)<sup>86,87</sup>. Trope *et al.* (1999) mentioned that the use of calcium hydroxide as an intracanal medicament increases the success rate of endodontically treated teeth in multiple visits compared to these that had empty root canals in the interappointment period<sup>56</sup>. However, the efficacy of calcium hydroxide in eliminating bacteria in root canal is questionable while *E. faecalis* presents resistance to calcium hydroxide<sup>35-39</sup>. Studies have shown that the complete removal of calcium hydroxide from the root canal system before the obturation is not possible<sup>88-91</sup>.

## Conclusions

There is no evidence that endodontic therapy in one or more sessions provides higher rates of periapical healing. In addition, the success rate of an endodontic therapy is a combination of a positive long-term outcome and the limitation of short-term complications. There is need of randomized controlled trials with a large enough sample size for statistical analysis.

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