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The Effect of Failure Root Canal Treatment on the Tooth: A Systematic Review

Laila Mohammed Alanazi[1*], Turki Nasser Alotaibi[2], Shaima Mohammed Alasimi[3], Hawazen Mohammad Alblehshi[4], Dalal Jumah Alturaif[1], Mohammed Fadil Alaqeedi[1]

[1]General Dentist, Private Clinic, Saudi Arabia
[2]General Dentist, Ministry of Health, Hail, Saudi Arabia
[3]General Dentist, Nahj Al-Ertifaa Medical Center, Abha, Saudi Arabia
[4]General Dentist, Care Community Health Center, Madina, Saudi Arabia

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***Corresponding author:** Laila Mohammed Alanazi
General Dentist, Private Clinic, Saudi Arabia

Abstract

The failure of root canal treatment occurs due to lack of standards or aspects of procedure were not followed accurately. Root canal treatment's failure can be justified by response ratio of teeth and procedural errors that limits the intracanal endodontic infection, but not control it properly as preventive measure. Although there was very little evidence regarding the predictive factors for tooth preservation, effects of failure of root canal system and tooth survival was investigated. Very few studies have been conducted to evaluate the clinical outcomes of failure of root canal treatment on tooth survival. Therefore, we will aim to design a systematic review to evaluate clinical outcomes of failure of root canal treatment on tooth survival. We conducted a systematic review by following "Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" guidelines related to title which was "The effect of failure root canal treatment on the tooth" according to study aims. The study selection criteria (as including both inclusion and exclusion criteria) were designed for screening and selection of collected data in recent systematic review. For recent systematic review, we collected about 67 studies related to the effect of failure root canal treatment on the tooth through searching from above mentioned databases About 7 out of remaining papers were up to the standard and met the above-mentioned criteria. The above included 7 studies were relevant to study aims and evaluated the effects of failed toot treatments or root canal treatment (RCT) on tooth survival, tooth health and safety. All included studies coded the major effects of failure root canal treatment as the swelling, (Topçuoğlu & Topçuoğlu, 2017 & Ulin *et al.,* 2020) prospective pain, (Ballal *et al.,* 2020, Wang *et al.,* 2010 & inflammation, (Verma *et al.,* 2019) and microbial attack (Chen *et al.,* 2017 & Jordan *et al.,* 2014) intensity. However, all studies have evaluated different root canal treatment with different non-surgical treatments. Overall, the clinical effects of failure of root canal treatment are severe and should be overcome with retreatment.

Keywords: Failure of root canal treatment (RCT), effects on tooth survival, tooth health.

1. INTRODUCTION

The failure of root canal treatment occurs due to lack of standards or aspects of procedure were not followed accurately. Root canal treatment's failure can be justified by response ratio of teeth and procedural errors that limits the intracanal endodontic infection, but not control it properly as preventive measure (Siqueira, 2001). Majorly reported factor behind the endodontic failure or root canal treatment failure was persistence of microbial infection which damages tissues of root canal system. These germs might have entered via the structural methods or entered the canal through apical root-illing leaking. According to research, the endodontic microbiome of teeth that underwent unsuccessful endodontic therapy is different from that of uninfected molars. (Peciuliene, 2001) There seems to be a fairly little variety of microbes, primarily gram-positive facultatively species, particularly *Enterococcus faecalis.* While preventive use of antibiotics has been advised for individuals at risk of bacteraemia during apical treatments, persistent infections, such as periodontal diseases in root-treated teeth, frequently do not necessitate antibiotic therapy (Stuart, 2006).

Root canal treatment and its success ratio exhibit it as highly applicable and effective procedure, expect in few clinical conditions. Among healthy patients, the success of root canal system depends upon the criteria, referential clues and adoption of presupposes. The tooth health after root canal system restores and persist its function, as it indicates the completion of treatment procedures, as evidences suggest (Topçuoğlu & Topçuoğlu, 2017). Multiple perspectives and values, such as those that relate to the dentistry, the patients, or the molar directly, can be used to examine the clinical effectiveness of RCTs. The significance of the side effect (therapeutic silence, lack of discomfort), the significance of the appearance (fully filled root canal area, no signs of periodontal infection), and the worth of the medical problem are standards for the dentistry (a well-restored and functioning tooth) (Estrela, *et al.*, 2008).

The root canal system has been exposed to various non-surgical treatments to prevent the tissue infection and remove necrotic parts through the well-condensed obturation which protects the canal system against further microbial proliferation. (Ricucci, 2005) The endodontic treatment and its efficacy measured by protection of root canal system against the microbial attack and ingestion for infection. However, the coronal seal of root canal system has been reported to be highly effective among non-surgical treatment (European Society of Endodontology 2006). Due to the impact of endodontic therapy, a root-illed tooth differs from a functional tooth. Root canal system therapy is hypothesized to cause the underlying tooth enamel to "reduce" as a consequence of a variety of causes, including changes in the proprioceptive system, dentine characteristics, and tooth morphology (Nair, 2005). Moreover, the anterior and posterior root canal system experience different outcomes under non-surgical treatment due to loading patterns of filling and tooth morphology. However, the effects of root canal treatment are similar on tooth health of both kinds due to same procedure (Maddalone & Gagliani, 2003).

For whether something the radiological characteristics and formulate a clinical assumption, the dentist's abilities are essential. The importance of the sensation (absence of pain) for the individual is crucial. The root canal treatment's success has been associated with treatment outcomes and elimination of future need of intervention. The reoccurrence of disease or infection in periapical sections indicates the failure of root canal treatment. Considering that biological and physical processes have a complex nature and can't be regarded independently is essential for comprehending the life of an endodontic treatment tooth. It is assumed that as many teeth as feasible would be kept in place until death. Effective RCT inhibits pain, apical periodontitis (AP), and dental problems, but it is difficult since a variety of clinical circumstances, such as endodontic incision, overstocking, root canal therapy and inflamed gums lesions, root rupture, periodontal bacteria, patients with traumatic damage, rupture of tool, AP, debridement, etc., can lead to a poor prognosis either alone or in combined effect. (Estrela *et al.*, 2014).

Dysfunction of endodontic therapy can be handled surgically or non-surgically. If non-surgical endodontics has failed and non-surgical endodontic treatment revascularization is not an option or has a worse outcome, apical operations, which includes periodontal curettage, root-end excisional, root-end preparing, and root-end filling, may well be performed. From last few years, the use of technology has replaced the surgical treatments with modern microsurgical techniques, novel root-end filling, and the use of magnification and enhanced illumination, and apical treatment, and the outcome or success ratio of these treatments have been high among others as 90% during 2 years of study as reported. (Kang *et al.*, 2015) Clinical evidence of postoperatively healing has been utilized as an outcome indicator for root canal procedures.

Few years ago, the studies generally and sizable demographic surveys both employed tooth retention as an outcome metric. Using the research published up to 2007, a recent meta-analysis evaluated the consolidated probability values of tooth survival by random controlled trail and the related clinical characteristics. They discovered that the pooled confidence intervals of tooth survival 2–10 years after root canal therapy were ranged from 86% to 93%. The significant variations in study parameters made it difficult to compare results directly (Ng *et al.*, 2010). Although there was very little evidence regarding the predictive factors for tooth preservation, meta-analyses of the evidence that was accessible revealed four situations that substantially expanded tooth viability. The evidence essentially confirms the commonly held belief that healthy tooth preservation is likely to be affected by the allocation, quantity, strength, and moral fiber of residual tooth tissue, anterior teeth and usable density on the molar, and the way that massive amount is dispersed within the enamel surface (Gulabivala 2004). Very few studies have been conducted to evaluate the clinical outcomes of root canal treatment on tooth survival. Therefore, we will aim to design a systematic review to evaluate clinical outcomes of failure of root canal treatment on tooth survival.

2. METHODS

2.1 Introduction

We conducted a systematic review by following "Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" (Selçuk, 2019) guidelines related to title which was "The effect of failure root canal treatment on the tooth" according to study aims. PRISMA guidelines were followed in recent study, for selection and screening of collected research articles, as shown in PRISMA flowchart, (Athikarisamy, & Patole, 2021) as figure 1.

2.2 Search Strategy

For recent systematic review, the comprehensive search strategy designed for data collection and extraction in accordance with research aims and title. About 5 databases were used for data search; collection and extraction include PubMed, MEDLINE, Cochrane library, EMBSE, and Science Direct, on 28 December, 2022. To search data, we used MeSH keywords of "failure of root canal treatment", "clinical effects of failed root canal treatment" "effect of failure of root canal treatment on toot", and "tooth survival and safety" among all databases. Only those research articles were extracted that have been published during January 2015 to December 2022.

After that, we designed a PICO model for selection of research articles, according to aims of systematic review. A good PICO question has four parts to identify the research population (P), type of implicated strategy or intervention (I), comparison (C) among experimental and control groups and outcomes (O). for recent systematic review, we designed PICO question for data selection as follows:

- P—patients with effected root canal system.
- I— effect of root canal treatment 's failure.
- C— experimental vs control group.
- O—tooth survival.

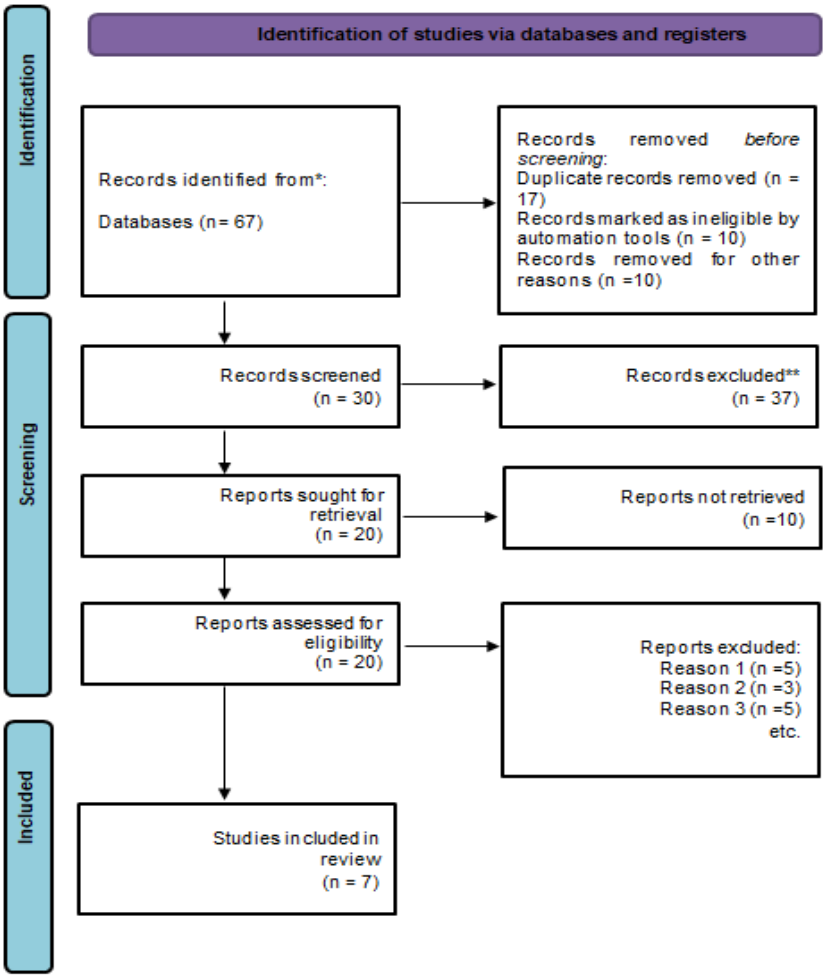

Fig. No 1: The PRISMA flowchart for screening and selection of standardized Research Articles

2.3 Study Selection

The study selection criteria (as including both inclusion and exclusion criteria) were designed for screening and selection of collected data in recent systematic review. To pursue PRISMA guidelines, the PRISMA flowchart was used for screening and selection of collected research articles. The selected articles were related to research aims including according to PICO question.

The inclusion criteria for recent systematic review include papers dealing with (1) randomized controlled trails, cohort studies, and pilot studies (2) study population are patients with root canal infection (3) evaluation of effect of failed root canal treatment (4) measuring outcomes as tooth health and safety (5) research articles published in English language.

The exclusion criteria f or this study were (1) case studies, narrative reviews, and already done

systematic review or meta-analysis (2) Research articles discussing other types of effects failed root canal treatment (3) studies dealing with patients other than tooth infection (4) articles published in other language rather than English.

2.4 Data Extraction

After following PRISMA guidelines for screening and selection, we extracted necessary data including author, year of publication, study type, research aim, sample size, research area, primary outcomes and results as table 1, about the effect of failure root canal treatment on the tooth.

2.5 Assessment of Study Quality

The quality of including studies were assessed through RevMan or review manager version 5.0 by evaluating each article on bases of different criteria, including random allocation, consolidation bias, study assessment and other risks bias. The diagram of risk bias will design as risk bias graph and risk bias summary.

2.6 Data Synthesis and Analysis

In recent systematic review, we have used the data synthesis technique which can integrate, interpret and analyze the data from qualitative, quantitative and mixed studies. Studies that had numerous features were coded to each of the indicated intervention areas and based on the study's reliability, which resulted in some of them being included multiple times in the results section. This method of categorizing treatments by similarities rather than taking into account the numerous parts of the treatment in its entirety unit is advised for reviews in order to assess the efficiency of certain program areas. The assessment of the research was then reported using a thematic analysis.

2.7 Ethical Considerations

In recent systematic review, there is no need of ethical approval because we are extracting data from previous published studies. Among those publishers of those studies, informed consent was obtained by research owners that have been retrieved and analyzed.

2.8 Summary

From data collection to screening and selection, all steps of recent study have been performed by following PRISMA guidelines. After extraction, the RevMan version 5.0 has been utilized for quality appraisal of included studies.

3. RESULTS

3.1 Identified Studies

For recent systematic review, we collected about 67 studies related to the effect of failure root canal treatment on the tooth through searching from above mentioned databases. According to the inclusion criteria, 20 papers were found to be related and reputable, as well as meeting the study's objectives. Due to duplication, around 13 study papers were removed from 20 studies using exclusion criteria. About 7 out of remaining papers were up to the standard and met the above-mentioned criteria.

3.2 Descriptive Analysis of Identified Studies

Among 7 selected studies, all were randomized controlled trails, cohort studies being conducted in China, India, Germany, Sweden, and turkey which represent different regions of world, with different endodontic treatments.

Table 1: The characteristics of included and selected studies

Authors, year	Study location	Study population	Study design	Objective	Findings
Topçuoğlu & Topçuoğlu, 2017	Turkey	45 patients	A randomized control trail	To evaluate the duration and intensity of pain as effects of failed root canal treatment after the removal of root canal filling material	Failure of non-surgical endodontic retreatment (NSER) causes postoperative pain in upper incisor teeth.
Verrma *et al.*, 2019	India	86 teeth patients	A randomized control trail	To investigate the effects of primary endodontic treatment failure in forms of postoperative pain and healing	The prospective pain and healing effects have been observed as major effects after failure of root canal system.
Jordan *et al.*, 2014	Germany	65 patients	multicenter, controlled, open-label trial	to investigate effects of failed basic root canal treatment (BRT) through radiographic and clinical outcomes	The basic root canal treatment (BRT) failure can reduce tooth survival and exposure to microbial infection
Chen *et al.*, 2017	China	155 children	cross-sectional study	to investigate the success rates of a mixed primary root canal filling and	The tooth filling with materials is commonly successful, but it failure

Authors, year	Study location	Study population	Study design	Objective	Findings
				effects of failure	may cause loss of filling and microbial attack.
Ulin *et al.*, 2020	Sweden	298 patients	A quasi-randomized controlled trial	To investigate the failed endodontics by evaluation of postoperative pain nor swelling.	A significantly higher incidence of postoperative swelling or pain was found in failed treatment greater concentration of NaOCl (3%).
Ballal *et al.*, 2020	India	48 individuals with dentin/pulp wound	Randomized Controlled Trial	To evaluate the frequency of early postoperative pain levels along with higher early treatment failures	Post-operative discomfort and pain have been associated with the failed endodontic treatment.
Wang *et al.*, 2010	China	89 patients	A randomized control trail	To examine the frequency and severity of post-obturation pain in primary molars following one- or two-visit root canal therapy (RCT).	Failure of RCT led to an increase in the frequency and severity of post-obturation pain experienced after one or two visits.

3.3 Key Results

The above included 7 studies were relevant to study aims and evaluated the effects of failed toot treatments or root canal treatment (RCT) on tooth survival, tooth health and safety. All included studies coded the major effects of failure root canal treatment as the swelling, (Topçuoğlu & Topçuoğlu, 2017 & Ulin *et al.*, 2020) prospective pain, (Ballal *et al.*, 2020, Wang *et al.*, 2010 & inflammation, (Verma *et al.*, 2019) and microbial attack (Chen *et al.*, 2017 & Jordan *et al.*, 2014) intensity. (However, all studies have evaluated different root canal treatment with different non-surgical treatments.

The effects of failure root canal treatment or non-surgical treatment of root canal system have been recognized as preoperative tooth, microbial attack frequency, swelling, discomfort and pain intensity, and post root canal treatment restorative effects. The 3 studies (Topçuoğlu & Topçuoğlu, 2017 Verma *et al.*, 2019 & Ulin *et al.*, 2020) have reported pain as general clinical effect observed after the failure of root canal treatment and 2 studies were reported to be finding the microbial attack ass major effect and sign of failure of root canal system (Chen *et al.*, 2017 & Jordan *et al.*, 2014) which can cause infection in tooth tissues. And other remaining studies were investigating discomfort and inflammation as major effects. However, there were no serious lesion of buccal or oral tissues were found as results of bacterial infection after failure of root canal treatment.

Only after determining that the tooth can be restored can root canal therapy be performed (Gulabivala 2004). There are currently no restorability parameters accessible to physicians to help them determine the survival prediction based on dental restorability that have been verified by long-term study results. In a prospective trial, the longevity of teeth with fractures before main treatment was specifically examined. 85.5 percent of these teeth had root canal therapy and remained intact for at least two years. (Jordan *et al.*, 2014) The quantity of pretreatment cracks had an impact on tooth survival, whereas the position or length of those cracks.

DISCUSSION

Based on this systematic review, the studies helped recognize the common mistakes made during the following clinical procedural steps: endodontic preparing, prognosis of pulp and peritoneal illness, general anesthesia, hole planning for connectivity, separation with gasket, endodontic treatment planning, stuffing and root canal therapy of the tooth root, reconstruction of restorative dentistry, post - operative pain, and adopt of restorative dentistry. An operational error can negatively affect the prognosis throughout any step of an RCT, and all these failures are what are known as failure risk factors. To prevent future issues with the dental health, it is crucial to be aware of likely operational procedural errors and their effects (Estrela, *et al.*, 2017).

The majority of study on tooth longevity might be categorised as retrospectively prospective studies, in similar to the studies on postoperatively recovery. Their main purpose was to provide answers to many clinical problems, some of which were concerned with the restoration's longevity and others with the replacement and tooth. (Chen *et al.*, 2008) The quality and scope of recorded facts for the analysis of prognostic factors are typically impaired, despite the possibility of recruiting a relatively large patient group from individuals covered

by commercial or public insurance programmes. These research' analysis of utilizing the available elements was, regrettably, constrained by what was contained in the healthcare organization database. They examined the longevity of root fillings installed by general dentists employed by the UK National Health Service (NHS), in contrast to the other research (Gulabivala, 2004).

Professionally, the type of treatment used may be influenced by the periodontal and restoration predictions of the tooth as determined by the dental. Removable restorations on teeth with lingering issues after root canal therapy or teeth with a questionable outcome are less likely to get approval from the doctor and the patient. One could counter that the theory is reinforced by the reality that no molars that had crown restorations failed. Moreover, the 36percent of root fillings that were unable to examine so because radiography couldn't be seen may have skewed their conclusion regarding the minimal impact of root refilling integrity. It's interesting that no of the substantial observational studies included information on the graph's dropout (Kolker *et al*., 2006).

Dysfunction of a root filling was indicated when one of the below occurrences: tooth removal, root fillings renewal, or tetrahedral surgery on the molar. After 10 years of the first root canal procedure, they discovered that 74% of the test teeth had survived without additional root canal therapy. The participant's age and medical history were discovered to be significantly linked with the longevity of root fillings (Lumely, 2008). Regrettably, the possible confounders were once again overlooked. The same doctor who performed the root canal procedure also installed the implants.

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