Systematic Review

Success of pulpotomy in mature permanent teeth with irreversible pulpitis: A systematic review

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Abstract

The objective of the present systematic review is to evaluate the success of pulpotomy in mature permanent teeth presented with irreversible pulpitis. The following databases were searched: PubMed, Oral and Dentistry Database, Cochrane, and CINAHL plus. We included studies published in the English language only. However, narrative reviews and case reports/series were excluded. The first electronic and hand search yielded a total of 2851 articles. After going through extensive screening and eligibility process, only six articles were finally selected for the review. The follow-up period ranged from 1 to 10 years. Randomized controlled trial compared pulpotomy with the root canal treatment and reported comparable and even better success of the pulpotomy (78% success). All the other studies have also shown better clinical and radiographic success of pulpotomy (68%–100%). Pulpotomy can be considered an alternative option for mature permanent teeth with irreversible pulpitis.

Keywords: Irreversible pulpitis; pulpotomy; root canal treatment

INTRODUCTION

Irreversible pulpitis is an inflammatory condition of the dental pulp that is characterized by spontaneous, lingering pain that persists for minutes to hours and can lead the pulp tissue to a state where it is incapable of self-healing.[1] The preferred treatment modality for teeth with irreversible pulpitis is the root canal treatment.[2] Studies have reported up to 95% success rate of the root canal treatment in teeth diagnosed with irreversible pulpitis.[3-5] However, despite having excellent prognosis, root canal treatment is associated with issues such as being, expensive and time-consuming than an extraction. Moreover, it requires meticulous skills.[6] Furthermore, currently, there is a lack of definite tool to accurately assess the actual status of pulpal inflammation, and thus, clinicians are to rely on surrogate measures such as clinical signs and symptoms and Hot/Cold test/EPT to decide for the root canal treatment.[7]

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complicated, less expensive, and less time-consuming. It also helps in giving the better assessment of level of inflammatory changes occurring in pulpal tissue depending on the hemostasis achieved.

Aguilar and Linsuwanont in his systematic review reported the success of pulpotomy in cariously exposed permanent teeth. In spite of this success and recognition of this treatment procedure as an emerging treatment modality, there is still relative hesitance and fear of failure to adopt pulpotomy as an alternative to conventional root canal treatment. There is also a lack of highest level of evidence in favour of pulpotomy treatment for teeth diagnosed with irreversible pulpitis. Therefore, the aim of this systematic review is to assess the clinical and radiographic success of pulpotomy in mature permanent teeth presented with the diagnosis of irreversible pulpitis.

MATERIALS AND METHODS

The following PICOS criteria were utilized as follows:

Patients: Human mature permanent posterior teeth diagnosed with irreversible pulpitis.

Intervention: Pulpotomy.

Comparison: With or without root canal-treated teeth were compared with the above-mentioned intervention.

Primary outcome: Lack of clinical and radiographic signs of failure.

Secondary outcome: Healing or resolution of periapical rarefaction after pulpotomy.

Study designs: Randomized clinical trials, quasi experimental studies, single arm intervention studies, and retrospective studies.

The review protocol was registered at the PROSPERO (an international database at the University of York, UK. CRD#42017075343). This helps to avoid any planned duplication. A comprehensive literature research was carried out from 2007 to February 2018 on four major health databases (PubMed [NLM], CINAHL Plus [EBSCO], Cochrane library, Dent and Oral Science including hand search). To identify any gray literature and unpublished data, SIGLE was explored, manual search on the Google scholar and in the database of www.clinicaltrials.gov. was also performed following MESH terms were used: “[Pulpotomy OR partial pulpotomy OR vital pulp therapy OR irreversible pulpitis” “Pulpectomy OR pulpotomy permanent teeth OR Root canal treatment in permanent teeth] AND [pulpectomy OR root canal treatment pulpotomy OR pulpectomy].

Table 1 summarizes the inclusion and exclusion criteria of the studies.

Study selection

The initial search resulted in 2851 hits. These were reviewed by one of the authors to exclude duplicates or studies irrelevant to the research question. Review of the titles of all the remaining probable studies was performed by two authors independently, and any conflict was decided through discussion with the third author. The reasons for the exclusion of studies were also mentioned. At the end, selected studies were the ones that answered our review question (i.e., pulpotomy as a successful alternative to the root canal treatment). Data (clinical and radiographic success rate, follow-up period, etc.,) from the included studies were assessed and noted on a customized self-administered pro forma. The reason for exclusion of studies is mentioned through PRISMA flowchart [Figure 1].

Risk of bias

The qualities of the included studies (individual and overall) were evaluated using the risk of bias assessment tool (The Cochrane collaboration’s tool) by the investigators. Using the risk of bias assessment tool, the studies were assigned as having high, low, or unclear risk of bias.

RESULTS

Six studies of 2851 fulfilled the inclusion criteria for the systematic review.[6-10,17-19] [Table 2]. Two studies were randomized controlled trial, two were single-arm interventional studies, and two were retrospective studies. All studies were published in recent years in high-impact factor journals.

The total number of teeth assessed in the included studies was 691. Kunert et al. and Asgary et al.[9,18] contributed maximum number of teeth (273 and 271, respectively).
whereas Qudeimat et al.\cite{10} contributed minimum numbers to the overall sample ($n = 13$). The primary outcome assessed in the studies was the lack of clinical and radiographic signs of failure, and the secondary outcome was the healing of periapical rarefaction after pulpotomy. The age of the patients in the included studies was 10–70 years. The follow-up period ranged from 1 to 10 years. The overall clinical success rate of reviewed studies was in the range of 66%–100% [Table 3]. The randomized controlled trial conducted by Asgary et al.\cite{9} compared pulpotomy with the root canal treated teeth for 5 years and reported better success of pulpotomy (78% for pulpotomy as compared to 75% for root canal), but the difference was statistically nonsignificant. Three studies\cite{8,9,19} reported the healing of periapical rarefaction with the success rates 78%, 98%, and 76%, respectively. The peri-apical healing was observed in results of the remaining studies, as shown in Table 3.

**Risk of bias**

The studies were evaluated for the risk of bias using the Cochrane's collaboration tool.\cite{16} Since the blinding of the participants was not possible in single-arm trials and retrospective studies, therefore, they have the highest risk of bias. The highest risk of bias was found in the study conducted by Kunert et al., Taha and Abdelkhader, Qudeimat et al., and Linsuwanont et al.\cite{8,10,18,19} Overall risk of bias was also assessed, and highest risk of bias was reported for randomization, blinding of participants followed by blinding of outcome assessment [Figures 2 and 3].

**DISCUSSION**

Pulpotomy, as a definitive treatment option for mature teeth with irreversible pulpitis, has been associated with controversies in the literature.\cite{15,20-23} However, now there is an emerging evidence, suggesting comparable success rates of pulpotomy with that of root canal treatment in teeth diagnosed with irreversible pulpitis.\cite{9,24} There was a systematic review, which was carried out on pulpotomy of cariously exposed permanent teeth.\cite{15} In the present review, we assessed the success of pulpotomy in cases of irreversible pulpitis. Although there is a high probability that cariously exposed teeth could lead to irreversible pulpitis, Agular et al. did not take this into account in their article.

We included only clinical trials and retrospective studies based primarily on pulpotomy as definitive treatment option, excluding those studies in which different materials were compared for pulpotomy. Asgary et al. did a randomized controlled trial, the results of which were published on yearly basis, so we mentioned the results of longest follow-up, i.e., 5 years.\cite{9}

Asgary et al.\cite{17} also carried out randomized controlled trial which had compared the different techniques of conservatively managing the irreversible pulpitis, so we included the results of just one arm of the study.\cite{15} The study by Kunert et al. was included as pulpotomy was performed on those teeth which were specifically referred to endodontist for endodontic treatment.\cite{18}

Assessing the status of the pulp plays a vital role in the success of the pulpotomy. Conventionally, carious exposure in mature teeth was considered as a proxy for irreversible

**Table 3: Success rate of the included studies**

| Studies               | Intervention | Follow-up (years) | Clinical success (%) | Radiographic success |
|-----------------------|--------------|-------------------|----------------------|----------------------|
| Asgary et al.         | Pulpotomy    | 5                 | 78                   | 66%                  |
| Kunert et al.         | Pulpotomy    | 1-10              | 63                   | Not mentioned        |
| Linsuwanont et al.    | Pulpotomy    | 3-4               | 84                   | 76%                  |
| Qudeimat et al.       | Pulpotomy    | 5                 | 100                  | 100%                 |
| Taha et al.           | Pulpotomy    | 1                 | 100                  | 98%                  |
| Asgary and Hassanizadeh| Pulpotomy   | 1                 | 91-95                | Not mentioned        |

**Figure 1:** PRISMA flow diagram
pulpitis irrespective of the symptoms.[25] Spontaneous or lingering pain and tenderness to percussion have been used as surrogate measures to evaluate irreversible damage to the pulp.[26] The histopathological data confirmed that the signs and symptoms and inflammation of the pulp at an exposure site are not correlated with the extent of the damage of the pulp.[27,28] Therefore, there is a lack of any reliable tool or test that helps to accurately measure the depth and extent of pulpal inflammation.

Relying on the time needed to achieve hemostasis during pulpotomy can be a better outcome measure to assess the level of pulpal inflammation. There is a high likelihood of inflammation being limited to the coronal pulp if the hemostasis is achieved within 1–10 min.[15] Results of the most of the studies of the current review reported 5–10 min of time needed to achieve hemostasis.[8,10,18,19] In a nutshell, this practice has changed the fundamentals of understanding the diagnosis and managing the irreversible pulpitis.[29,30]

Healing of periapical rarefication in teeth with irreversible pulpitis is well documented.[8] Studies in the present review have also shown the healing of periapical rarefication following pulpotomy treatment.[8,9,19] The reason for this association of periapical rarefication with the irreversibly inflamed pulp is due to the neurogenic inflammation that precedes the pulpal necrosis, as bacterial contamination leads to complex interaction of inflammatory mediators, cytokines and neuropeptides from afferent fibres to pulp and then to periapical tissue.[9]

There is a debate over the follow-up time to declare the pulpotomized teeth successful. Studies have reported 6 months’ time to be adequate for the success of pulpotomy; however, long-term follow-up is still required with regard to latency of biological complications (root resorption, necrosis, and development or increase in size of periapical lesion).[13,31,32] In the current review, the follow-up period ranged from 1 to 10 years. The reported complications were the development of painful pulpitis, pulpal obliteration, and periapical rarefication.[8,10,19] with the success rate that drops from 89% at 1 year to 63 at 10 years.[18]

After carrying out a detailed and thorough literature search, the present review is said to be the first of its kind in assessing the success of pulpotomy in mature permanent teeth diagnosed with irreversible pulpitis. The evidence of this review is based on trials and retrospective studies with a good follow-up period. Risk of bias assessment of individual and overall studies were performed. The limitations are that only one randomized controlled trial was included and due to the inclusion of retrospective studies, there is a chance of bias. There was another randomized controlled trial that compared different conservative treatment modalities of managing teeth with irreversible pulpitis, so we included the results of one arm of the study. We recommend carrying out more randomized controlled trial, with a longer follow-up period.

CONCLUSIONS

It appears that pulpotomy is a successful treatment modality for permanent teeth presenting with irreversible pulpitis. However, this inference must be interpreted with caution as it’s drawn from primary studies with multiple biases and design limitations. Thus, high quality randomized controlled trials with long term follow-ups are warranted before advocating the superiority of pulpotomy over pulpectomy in these cases.

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Conflicts of interest

There are no conflicts of interest.

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