IEJ
Iranian Endodontic Journal

Challenging the Misnomer of Irreversible Pulpitis and Deliberating the Urgent Need for Reclassification of Pulpal Diseases Based on the Efficacy of Vital Pulp Therapies: An Overview of Systematic Reviews

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Article Type: **Review Article**

Received: 10 May 2023
Revised: 19 Jul 2023
Accepted: 03 Aug 2023
Doi: *10.22037/iej.v18i4.43035*

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Over recent decades, the definition of irreversible pulpitis (IP), as an irrevocable condition of a compromised dental pulp tissue, has forced clinicians towards invasive root canal treatments. However, the current best evidence challenges the alignment between clinical symptoms and the perceived irreversibility of a negotiated dental pulp tissue. In the above-mentioned context, vital pulp therapy (VPT) has emerged as a revolutionary and transformative approach; introducing minimally invasive techniques to sustain pulp vitality in cases of IP. The present paper aimed to rigorously examine the corresponding published systematic reviews to explore the diverse spectrum of VPT modalities and their outcomes in managing IP cases. Besides, the current review seems to have asserted the need to discard the conventional terminology of *irreversible pulpitis*, based on the effectiveness of VPTs in the achievement of pulp tissue healing within cases clinically diagnosed as IP.

Keywords: Irreversible pulpitis, Pulp capping, Pulpotomy, Systematic reviews, Vital pulp therapy

Introduction

Dental pulp inflammation, commonly known as pulpitis, presents a major challenge in the field of endodontics. Irreversible pulpitis (IP), in particular, has traditionally dictated invasive root canal treatment (RCT) due to the prevailing notion that compromised pulpal tissue lacks the ability to heal/regenerate. However, recent advancements in endodontic research and treatment strategies have cast doubt on the stated customary concept [1-3].

Irreversible pulpitis has usually been identified through clinical sign and symptoms; e.g. spontaneous pain, lingering discomfort, and thermal sensitivity. This symptomatic diagnosis has historically guided treatment decisions towards aggressive RCT. Nonetheless, emerging scientific evidence has introduced a discrepancy between clinical symptoms and the histopathological state of pulpal tissue [1]. This incongruence has prompted a re-evaluation of the diagnostic criteria for IP and an exploration of alternative therapeutic avenues.

The conventional understanding of IP has served as a cornerstone in endodontic diagnosis and treatment planning. The American Association of Endodontists (AAE) defines IP as a clinical diagnosis based on–both–subjective and objective indications that the inflamed vital pulp cannot undergo healing [4]. This definition includes characteristics such as lingering thermal discomfort, spontaneous pain, and referred pain. However, the European Society of Endodontology (ESE) emphasises a comprehensive diagnostic approach that encompasses history-taking, clinical examination, pulp sensibility testing, and radiographic assessment to determine the inflammatory state of the pulp [5]. Irreversible pulpitis manifests symptomatic and asymptomatic presentations, each with distinct clinical features [6]. These traditional definitions have forced clinicians towards pulpectomy and RCT based on the notion that such a pulp cannot heal and/or regenerate.

Using biocompatible materials [7-9], vital pulp therapy (VPT) has re-emerged as a promising alternative to RCT for cases of IP [10, 11]. VPT encompasses a spectrum of minimally

invasive techniques aimed to preserve the vitality of affected pulpal tissues; including stepwise excavation, direct/indirect pulp capping (DPC/IPC), miniature/partial/full pulpotomy (MP/PP/FP) and partial pulpectomy [12, 13]. The transition towards VPT is driven by its potential to retain tooth vitality and function as well as its capacity to simplify treatment procedures, mitigate patient discomfort, and enhance treatment outcomes [14-16].

Numerous randomised clinical trials and systematic reviews have investigated the outcomes of VPTs in cases involving carious pulp exposure, reversible pulpitis, or mixed conditions of IP and other dental pulp conditions [2, 3, 10, 11, 16, 17]. These studies have consistently reported favourable outcomes. However, the present review delves deeper into the potential of inflamed yet viable pulp tissues, exactly in cases of IP. Not only does it highlight the various modalities of VPT explored in the literature, but it provides a deep insight into the outcomes.

The current comprehensive overview underscores the necessity to reconsider the nomenclature associated with IP in light of the evolving understanding of pulp tissue response to inflammation and its potential for reversibility through VPTs. It advocates a departure from traditional terminology and encourages a reclassification that aligns with the emerging evidence of pulp tissue healing, even in cases previously labelled *Irreversible*.

Materials and Methods

Search strategy: To gather relevant articles for this review, a comprehensive search was conducted on two major scientific databases; i.e. PubMed and Scopus. The search strategy aimed to identify articles which *only* discussed the topic of "irreversible pulpitis" (no other conditions) within the context of systematic reviews. "Irreversible pulpitis" AND "systematic review" were used as keywords and Boolean operators.

Results

A total of 74 and 87 articles were retrieved from PubMed and Scopus, respectively. The articles were then screened/selected based on their relevance to the topic and alignment with the scope of the current overview. The 15 selected systematic reviews [18-32] included in this review collectively investigated the efficacy of various VPT interventions in managing IP. Table 1 provides a comprehensive overview of systematic reviews conducted between 2019 and 2022, each focusing on the evaluation of different VPTs for cases of IP. The interventions encompassed FP, PP, DPC, and IPC.

Across the studies, FP emerged as a recurring intervention of interest. Systematic reviews and meta-analyses demonstrated that FP was a viable treatment option and prospective substitute for RCT in managing permanent teeth with carious pulp exposures, even in cases of IP [19, 21, 24, 25, 27-32].

In addition, PP was investigated as a viable treatment option with a high success rate in treating cariously exposed permanent posterior teeth [18, 22, 28]. Furthermore, IPC and DPC were explored, with researchers emphasising their efficacy for the management of cariously exposed pulps in permanent teeth, even with IP [20, 23, 26, 28, 30].

It is noteworthy that favourable treatment outcomes and conclusions were reported by the systematic reviews; reflecting the diversity of interventions and methodologies used. All studies included in this overview specifically examined the efficacy of pulp therapy interventions in cases of IP and consistently reported favourable treatment results in the management of such cases employing VPT techniques.

Discussion

The aim of the current overview of systematic reviews was to explore the efficacy of different VPTs in managing IP cases, and to consider the implications of obtained findings for the terminology surrounding IP. The analysis of the selected studies, as presented in Table 1, sheds light on the growing body of evidence; suggesting that the traditional notion of IP is in need of reconsideration.

The selected studies collectively examined a range of VPT interventions; including FP, PP, DPC, and IPC. Notably, the systematic reviews consistently investigated the application of the mentioned modalities, specifically to the cases of IP; which can challenge the conventional understanding that believes IP inevitably leads to non-healing pulpal tissue.

The recurring theme across the investigated systematic reviews is the high success rates reported in managing cases of IP using various VPTs. *Full pulpotomy*, in particular, emerged as a prominent intervention with substantial evidence supporting its viability as an alternative to RCT for permanent teeth with carious pulp exposures and IP [21, 24, 32]. Besides, other studies have supported the use of other VPT techniques in the same or comparable circumstances [20, 22, 30].

The reliable outcomes reported across the selected studies collectively advocate a reconsideration of IP terminology. The incongruity between the historical classification of IP [4] and the positive outcomes observed with VPT interventions emphasises the need and necessity for a new conceptual framework and

Table 1. Summary of systematic reviews on various vital pulp therapies for irreversible pulpitis

	Authors (year)	Intervention	Study design	No. of articles	Conclusions based on the treatment outcomes
1	**Li *et al.* (2019) [24]**	FP	rct	21	FP is a prospective substitute for RCT in managing permanent teeth with carious pulp exposures, even in permanent teeth with IP.
2	**Cushley *et al.* (2019) [21]**	FP	Cohort, rct	8	The evidence suggests high success for FP for teeth with signs and symptoms of IP.
3	**Zanini *et al.* (2019) [32]**	FP	Clinical trials	53	There is no evidence to recommend one single procedure for FP in vital permanent teeth that can be indicated for different pulpal diagnoses which differ greatly in terms of the inflammation process from healthy teeth to IP.
4	**Sadaf (2020) [27]**	FP	Cohort, rct	14	The evidence-based review facilitates clinical decision making in states to choose FP over RCT in mature permanent teeth with IP.
5	**Zafar *et al.* (2020) [31]**	FP	Cohort, rct	6	FP can be considered an alternative option for mature permanent teeth with IP.
6	**Madurantakam (2022) [25]**	FP	rct	4	FP is not inferior to the conventional RCT for the management of acute IP in mature permanent teeth in adults.
7	**Skitioui *et al.* (2022) [29]**	FP	rct	4	FP is not inferior to RCT for a permanent treatment of IP. In addition, the results obtained have shown that FP is faster and more profitable in all situations compared to RCT.
8	**Ather et al. (2022) [19]**	FP	Cohort, rct	11	The study determines the clinical outcome of FP for carious teeth with IP and its predictors for success.
9	**Elmsmari *et al.* (2019) [22]**	PP	Cohort, rct	11	PP results in high success rates in treating cariously exposed permanent posterior teeth up to 2 years.
10	**Albaiti *et al.* (2022) [18]**	PP	rct	4	PP showed a high success rate in treating cariously exposed permanent posterior teeth for up to 24 months.
11	**Cushley *et al.* (2021) [20]**	DPC	Cohort, rct	14	Low-quality evidence suggests a high success rate for DPC in teeth with cariously exposed pulps with better long-term outcomes for CSC compared with CH.
12	**Ruiz-González *et al.* (2022) [26]**	DPC	Clinical trials	4	DPC should be clinically included as a successful technique for the treatment of IP.
13	**Santos *et al.* (2021) [28]**	DPC, PP, FP	Cohort, rct	12	Reported favorable outcomes of the VPT performed with CSC in permanent mature posterior teeth with symptomatic IP, with radiographic success in the range of 81-90%. Two articles suggested comparable outcomes of VPT and RCT.
14	**Tong *et al.* (2022) [30]**	IPC, DPC, FP	rct	12	All treatment modalities were equally efficient with high overall success rates. Completion of root development was achieved in more than 83% of the cases.
15	**García-Mota *et al.* (2022) [23]**	IPC, DPC	rct	10	Light-cured CSC showed a limited clinical performance as a DPC agent, especially when evaluated in the long term. However, using it as an IPC agent may be a reliable and easy-to-use option for restoring teeth with deep caries.

FP=Full Pulpotomy, RCT=Root Canal Treatment, IP=Irreversible Pulpitis, PP=Partial Pulpotomy, DPC=Direct Pulp Capping, IPC=Indirect Pulp Capping, rct=randomized clinical trials, CSC=calcium silicate-based cement, CH = calcium hydroxide

terminology. The evidence suggests that the term irreversible may no longer accurately describe the nature of pulpitis in these and similar cases, as the pulpal tissue appears to retain its healing potential.

In conclusion, the results of the current comprehensive summary of systematic reviews, as the best evidence, highlighted the efficacy of VPTs in managing cases with IP and thus, raised an important question on the accuracy of the existing terminology of IP. The evidence presented can challenge the historical assumption that the dental pulp tissue affected by IP would be inherently non-healing. Instead, the achieved findings suggested that a more nuanced perspective is necessary; one that could recognise the potential for healing and tissue recovery in the context of pulpitis. Therefore, this study strongly recommends the re-consideration of alternative and simplified terminology, *e.g. pulpitis*, which may capture the dynamic nature and remarkable healing capacity in compromised dental pulp tissue responses in such and similar cases more accurately.

Conflict of Interest: 'None declared'.

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Please cite this paper as: Asgary S, Eghbal MJ. Challenging the Misnomer of Irreversible Pulpitis and Deliberating the Urgent Need for Reclassification of Pulpal Diseases Based on the Efficacy of Vital Pulp Therapies: An Overview of Systematic Reviews. Iran Endod J. 2023;18(4): 202-5. *Doi: 10.22037/iej.v18i4.43035.*