

Vital Pulp Therapy in Permanent Teeth

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ABSTRACT

This review article aimed to evaluate the outcome of vital pulp therapy procedures including indirect pulp capping (IDPC), direct pulp capping (DPC), miniature pulpotomy (MP), partial pulpotomy (PP) and full pulpotomy (FP) in permanent teeth even with signs of reversible and irreversible pulpitis. Instead of complete pulp tissue removal by pulpectomy, vital pulp therapy has been considered as an alternative approach. Articles published after 2000 were searched in PubMed and GoogleScholar online databases according to PRISMA guidelines. Forty articles were selected according to the inclusion and exclusion criteria. Eighty-five cases from case series and case report studies and also results of 20 clinical articles were included in this study. The success rate of partial and full pulpotomy in permanent teeth with signs of reversible and irreversible pulpitis was 98.8%. The success rate for both partial and full pulpotomies with mineral trioxide aggregate and calcium silicate-based cements in the current review of clinical studies was 84.6%-100% and 78.9%-100%. Partial and full pulpotomies demonstrated favourable outcomes and a high success rate in treating permanent teeth. So the vital pulp therapy procedures in permanent teeth with signs of pulpitis can be more successful, cost-effective and time-saving compared to traditional root canal treatment. However further well-designed studies with longer follow-up periods are required to validate these findings.

Keywords: Vital pulp therapy, Pulpotomy, Partial pulpotomy, Permanent teeth, Irreversible pulpitis

INTRODUCTION

Dental caries is an infectious disease and the most common cause of pulpal inflammation (Kumar et al., 2020). Pulpitis caused by caries is the main reason for root canal treatment. Instead of complete pulp tissue removal by pulpectomy, vital pulp therapy has been considered as an alternative approach (Linsuwanont et al., 2017). As a minimally-invasive approach, vital pulp therapy includes stepwise excavation of decayed tissues, direct/indirect pulp capping, partial/full pulpotomy and partial pulpectomy (Asgary et al., 2021). Direct pulp capping (DPC) involves treatment of the vital pulp exposure by sealing the pulpal wound by directly placing a biomaterial on the exposed pulp to facilitate the formation of reparative dentin and maintain the vitality of the pulp (Asgary et al., 2014). Miniature pulpotomy (MP) was defined as the procedure with gentle/limited removal of the infected dentin chips/damaged pulp tissue specially the injured odontoblast cell layer after direct exposure of the pulp tissue that would not exceed 1 mm (Asgary et al., 2014). Partial pulpotomy is the surgical removal of a small portion of the coronal pulp tissue to preserve the remaining coronal and

radicular pulp (Asgary et al., 2014). Pulpotomy procedures include removal of the coronal pulp with inflammation, which is under exposure. This is followed by inserting a particular material in addition to a restoration (Hakami et al., 2020). The aim of vital pulp therapy techniques is to seal the pulp wound, induced odontoblast-like cell differentiation and stimulate dentin secretion and mineralization (Mousavi et al., 2016). Recent studies have suggested vital pulp therapy as a realistic treatment modality for pulp exposure with supposed irreversible pulpitis. They have recommended vital pulp therapy as a biological, conservative, economic and simple method with a favourable prognosis (Asgary et al., 2013). Materials used as a pulp protecting agent should be biocompatible, be able to induce hard tissue formation, bactericidal, create a long-lasting biological seal and It should maintain pulp vitality (Grosman, 2021; Nosrat et al., 2013). In many studies materials such as mineral trioxide aggregate (MTA), calcium silicate-based cements (biodentine, bioaggrigate, calcium-enriched cements) and even platelet concentrate (PRF) are recommended to use in vital pulp therapy (Grosman, 2021; Ghani & Noorani, 2021).

MATERIAL AND METHODS

This review of the literature was performed in compliance with the PRISMA guidelines for systematic review. Data was collected from electronic databases such as PubMed and Google scholar. Searching terms include “Vital pulp therapy”, “Pulpotomy”, “Partial pulpotomy”, “Permanent teeth”, “pulpitis” connected by a Boolean operator “AND” (e.g., PubMed search strategy: “Vital pulp therapy” AND “Pulpitis” AND “Permanent teeth”). Three textbooks were hand searched. All the titles as well as abstracts that appeared from this search, were reviewed. Specific inclusion criteria and exclusion criteria that were used to select the studies for review are mentioned in table 1.

RESULTS

The search process resulted in a total of 309 articles. After a preliminary screening of the titles and abstracts, 193 irrelevant articles and 6 duplicates articles were excluded. The articles in which their full-text was available (61 articles) were collected and printed. Finally, after studying full-text of 40 articles were recorded according to the inclusion and exclusion criteria (Figure 1).

According to table 2: a total of 85 cases, 55.3% of which were women, were collected from case series and case report studies and the cases data were recorded in SPSS software. In 81.2% of cases, there was irreversible pulpitis and in other cases there was reversible inflammation of the pulp. In terms of diagnosis of periapical status, 42.4% had symptomatic apical periodontitis and 28.2% had also radiolucency and apical lesions. In 89.4% of cases, a full pulpotomy procedure was performed that in 71.8% MTA was used as vital pulp therapy material. Finally, the success rate of studying the total of these cases was 98.8%.

Inclusion criteria	Exclusion criteria
Human clinical study	Poor data reported
Procedures performed in permanent teeth	Studies did not used human teeth
Pulp exposures and diagnosis of reversible and irreversible pulpitis	Procedures performed in deciduous teeth
Procedures include DPC, MP, PP or FP	Non-specific data reported
Full-text available	Narrative review
Systematic review	Other procedures such as apexification and apexogenesis
Clinical trials	Unavailability of full-text article
Case reports	Studies were about material used in vital pulp therapy
Case series	
Cohort study	

When the title and abstracts were considered relevant the full-text of the article was reviewed. Full-text of eligible articles were also evaluated to ensure the article contents were relevant. All information about each case from case series and case report studies were collected and recorded in IBM SPSS. The study characteristics (year of publication), participant characteristics (age, gender, type of tooth, condition of tooth prior to treatment, pulpal and apical diagnosis), treatment (type of vital pulp therapy, materials and follow-up periods), and the outcomes (success rates) were collected from the article.

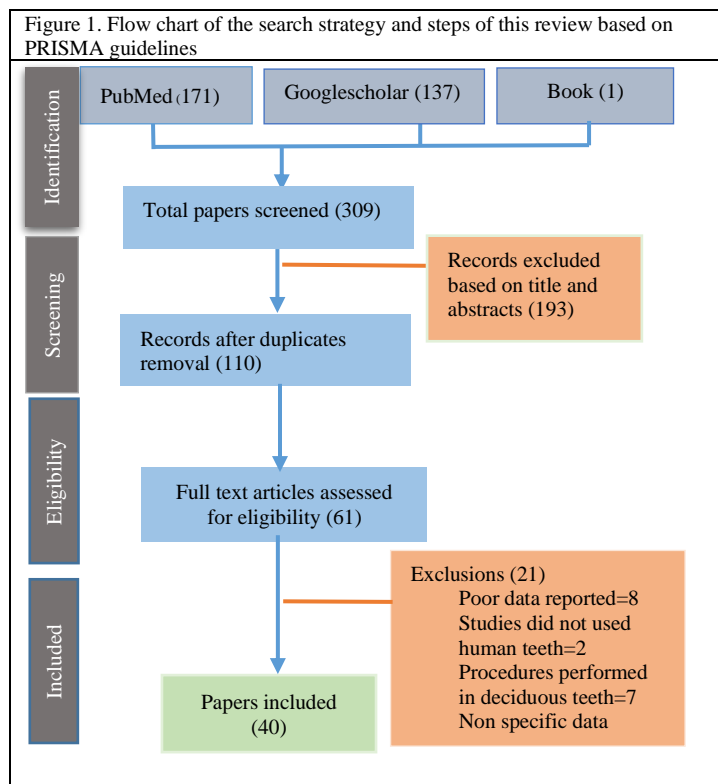


Table 2. Cases recorded from case report and case series studies

Number	Gender	Age	Tooth	Condition of tooth	Pulpal diagnosis	Apical diagnosis	RAD (pre-apical changes)	Fallow-up (Min)	Treatment	Material	Bleeding stoppage time	Result	Reference
1	Male	39	46	Carious	Irreversible pulpitis	None	No	18	FP	MTA	2	Failed	(Yousef et al.)
2	Female	19	36	Carious	Irreversible pulpitis	None	No	18	FP	MTA	0	Success	(Dr.Anil Munavalli, 2018)
3	Female	35	46	Carious	Reversible pulpitis	None	No	6	FP	MTA	10	Success	(C Nandha Kumar, 2018)
4	Female	28	36	Carious	Reversible pulpitis	None	No	6	FP	MTA	10	Success	(C Nandha Kumar, 2018)
5	Female	41	36	Carious	Reversible pulpitis	None	No	6	FP	MTA	10	Success	(C Nandha Kumar, 2018)
6	Male	14	47	Carious	Irreversible pulpitis	None	No	12	FP	MTA	0	Success	(Shahnaz et al.)
7	Female	37	44	Carious	Reversible pulpitis	None	No	18	FP	MTA	4	Success	(Bakar, 2020)
8	Female	37	45	Carious	Irreversible pulpitis	None	No	18	FP	MTA	4	Success	(Bakar, 2020)
9	Female	9	36	Carious	Irreversible pulpitis	AAP	Yes	60	PP	Biodentine	4	Success	(Chinadet et al., 2019)
10	Female	24	37	Carious	Irreversible pulpitis	None	Yes	15	MP	CEM	0	Success	(Ramazani & Asgary, 2018)
11	Female	38	37	Carious	Irreversible pulpitis	SAP	Yes	18	MP	CEM	3	Success	(Asgary et al., 2016)
12	Male	40	36	Carious	Irreversible pulpitis	SAP	No	18	MP	CEM	0	Success	(Asgary et al., 2016)
13	Female	9	36	Carious	Irreversible pulpitis	None	Yes	17	FP	CEM	1	Success	(M. E.-S. Sharaan & Abo Elsoud, 2017)
14	Female	10	46	Carious	Irreversible pulpitis	SAP	Yes	17	FP	CEM	1	Success	(M. E.-S. Sharaan & Abo Elsoud, 2017)
15	Female	14	46	Carious	Irreversible pulpitis	SAP	No	17	FP	CEM	2	Success	(M. E.-S. Sharaan & Abo Elsoud, 2017)
16	Male	11	16	Carious	Irreversible pulpitis	SAP	Yes	16	FP	CEM	3	Success	(M. E.-S. Sharaan & Abo Elsoud, 2017)
17	Male	15	36	Carious	Irreversible pulpitis	SAP	Yes	16	FP	CEM	1	Success	(M. E.-S. Sharaan & Abo Elsoud, 2017)
18	Male	13	36	Carious	Irreversible pulpitis	SAP	Yes	17	FP	CEM	8	Success	(M. E.-S. Sharaan & Abo Elsoud, 2017)
19	Female	12	26	Carious	Irreversible pulpitis	SAP	No	16	FP	CEM	10	Success	(M. E.-S. Sharaan & Abo Elsoud, 2017)
20	Female	13	36	Carious	Irreversible pulpitis	SAP	No	17	FP	CEM	12	Success	(M. E.-S. Sharaan & Abo Elsoud, 2017)

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21	Female	20	46	Carious	Reversible pulpitis	None	Yes	28	FP	MTA	5	Success	(Barnkgei et al., 2013)
22	Female	20	45	Carious	Reversible pulpitis	None	No	24	FP	MTA	5	Success	(Barnkgei et al., 2013)
23	Male	23	44	Carious	Reversible pulpitis	None	No	24	FP	MTA	5	Success	(Barnkgei et al., 2013)
24	Male	17	24	Carious	Reversible pulpitis	None	No	26	FP	MTA	5	Success	(Barnkgei et al., 2013)
25	Male	17	25	Carious	Reversible pulpitis	None	No	28	FP	MTA	5	Success	(Barnkgei et al., 2013)
26	Male	26	28	Carious	Reversible pulpitis	None	No	30	FP	MTA	5	Success	(Barnkgei et al., 2013)
27	Male	26	16	Carious	Reversible pulpitis	None	No	24	FP	MTA	5	Success	(Barnkgei et al., 2013)
28	Female	54	31	Carious	Reversible pulpitis	None	No	26	FP	MTA	5	Success	(Barnkgei et al., 2013)
29	Female	38	34	Carious	Reversible pulpitis	None	No	42	FP	MTA	5	Success	(Barnkgei et al., 2013)
30	Female	42	36	Carious	Reversible pulpitis	None	No	42	FP	MTA	5	Success	(Barnkgei et al., 2013)
31	Female	24	37	Carious	Reversible pulpitis	None	No	42	FP	MTA	5	Success	(Barnkgei et al., 2013)
32	Female	9	36	Carious	Irreversible pulpitis	SAP	No	24	FP	MTA	20	Success	(Qudeimat et al., 2017)
33	Female	10	46	Carious	Irreversible pulpitis	SAP	Yes	67	FP	MTA	17	Success	(Qudeimat et al., 2017)
34	Male	8	26	Carious	Irreversible pulpitis	SAP	No	60	FP	MTA	7	Success	(Qudeimat et al., 2017)
35	Female	9	26	Carious	Irreversible pulpitis	SAP	No	73	FP	MTA	5	Success	(Qudeimat et al., 2017)
36	Male	11	46	Carious	Irreversible pulpitis	SAP	Yes	72	FP	MTA	20	Success	(Qudeimat et al., 2017)
37	Male	11	36	Carious	Irreversible pulpitis	SAP	Yes	72	FP	MTA	20	Success	(Qudeimat et al., 2017)
38	Female	9	16	Restored	Irreversible pulpitis	None	No	68	FP	MTA	5	Success	(Qudeimat et al., 2017)
39	Female	12	36	Restored	Irreversible pulpitis	SAP	No	63	FP	MTA	15	Success	(Qudeimat et al., 2017)
40	Male	11	46	Carious	Irreversible pulpitis	SAP	Yes	19	FP	MTA	15	Success	(Qudeimat et al., 2017)
41	Male	9	36	Carious	Irreversible pulpitis	SAP	No	68	FP	MTA	22	Success	(Qudeimat et al., 2017)
42	Male	11	36	Restored	Irreversible pulpitis	SAP	No	61	FP	MTA	15	Success	(Qudeimat et al., 2017)
43	Male	11	16	Carious	Irreversible pulpitis	AAP	Yes	61	FP	MTA	5	Success	(Qudeimat et al., 2017)
44	Male	11	36	Carious	Irreversible pulpitis	SAP	No	67	FP	MTA	21	Success	(Qudeimat et al., 2017)
45	Male	10	36	Carious	Irreversible pulpitis	SAP	No	60	FP	MTA	20	Success	(Qudeimat et al., 2017)
46	Male	10	26	Carious	Irreversible pulpitis	None	No	60	FP	MTA	5	Success	(Qudeimat et al., 2017)
46	Male	10	16	Carious	Irreversible pulpitis	None	No	60	FP	MTA	5	Success	(Qudeimat et al., 2017)
48	Female	8	36	Carious	Irreversible pulpitis	SAP	No	56	FP	MTA	15	Success	(Qudeimat et al., 2017)
49	Female	13	26	Carious	Irreversible pulpitis	SAP	Yes	56	FP	MTA	24	Success	(Qudeimat et al., 2017)
50	Female	13	37	Carious	Irreversible pulpitis	SAP	Yes	55	FP	MTA	17	Success	(Qudeimat et al., 2017)
51	Female	13	47	Carious	Irreversible pulpitis	SAP	No	55	FP	MTA	22	Success	(Qudeimat et al., 2017)
52	Female	13	46	Carious	Irreversible pulpitis	None	No	55	FP	MTA	10	Success	(Qudeimat et al., 2017)
53	Female	7	46	Carious	Irreversible pulpitis	SAP	No	51	FP	MTA	25	Success	(Qudeimat et al., 2017)
54	Male	11	26	Carious	Irreversible pulpitis	SAP	No	37	FP	MTA	25	Success	(Qudeimat et al., 2017)
55	Male	12	46	Carious	Irreversible pulpitis	None	No	18	FP	Biodentine	5	Success	(Soni, 2016)
56	Male	36	14	Carious	Irreversible pulpitis	None	No	24	FP	CEM	5	Success	(Asgary et al., 2018)

57	Male	36	15	Carious	Irreversible pulpitis	None	No	24	FP	CEM	5	Success	(Asgary et al., 2018)
58	Female	8	19	Carious	Irreversible pulpitis	SAP	Yes	18	PP	Biodentine	0	Success	(Ashraf et al., 2017)
59	Male	8	9	Carious	Irreversible pulpitis	None	No	36	FP	CEM	0	Success	(Ashraf et al., 2017)
60	Male	35	36	Carious	Irreversible pulpitis	AAP	Yes	6	FP	CEM	3	Success	(Asgary & Kemal Çalışkan, 2015)
61	Female	40	45	Carious	Irreversible pulpitis	SAP	Yes	12	FP	Biodentine	2	Success	(Tran et al., 2021)
61	Female	25	36	Carious	Irreversible pulpitis	SAP	Yes	24	FP	Biodentine	0	Success	(Tran et al., 2021)
63	Male	13	46	Carious	Irreversible pulpitis	SAP	No	18	FP	MTA	2	Success	(M. Sharaan & Ali, 2019)
64	Male	13	16	Carious	Irreversible pulpitis	None	No	20	FP	MTA	1	Success	(M. Sharaan & Ali, 2019)
65	Female	11	26	Carious	Irreversible pulpitis	None	No	23	FP	MTA	2	Success	(M. Sharaan & Ali, 2019)
66	Female	11	46	Carious	Irreversible pulpitis	None	No	23	FP	MTA	2	Success	(M. Sharaan & Ali, 2019)
67	Female	8	36	Carious	Irreversible pulpitis	SAP	Yes	12	FP	MTA	2	Success	(M. Sharaan & Ali, 2019)
68	Male	8	36	Carious	Irreversible pulpitis	None	No	12	FP	MTA	1	Success	(M. Sharaan & Ali, 2019)
69	Male	13	46	Carious	Irreversible pulpitis	None	No	16	FP	MTA	1	Success	(M. Sharaan & Ali, 2019)
70	Male	8	16	Carious	Irreversible pulpitis	SAP	No	16	FP	MTA	5	Success	(M. Sharaan & Ali, 2019)
71	Female	9	46	Carious	Irreversible pulpitis	None	No	12	FP	MTA	5	Success	(M. Sharaan & Ali, 2019)
72	Female	13	46	Carious	Irreversible pulpitis	None	No	18	FP	MTA	12	Success	(M. Sharaan & Ali, 2019)
73	Male	9	36	Carious	Irreversible pulpitis	None	Yes	12	FP	MTA	10	Success	(M. Sharaan & Ali, 2019)
74	Male	12	46	Carious	Irreversible pulpitis	SAP	Yes	12	FP	MTA	5	Success	(M. Sharaan & Ali, 2019)
75	Male	12	26	Carious	Irreversible pulpitis	None	No	12	FP	MTA	10	Success	(M. Sharaan & Ali, 2019)
76	Female	10	46	Carious	Irreversible pulpitis	None	No	12	FP	MTA	5	Success	(M. Sharaan & Ali, 2019)
77	Male	11	16	Carious	Irreversible pulpitis	None	No	12	FP	MTA	5	Success	(M. Sharaan & Ali, 2019)
78	Female	8	26	Carious	Irreversible pulpitis	None	No	12	FP	MTA	5	Success	(M. Sharaan & Ali, 2019)
79	Female	10	26	Carious	Irreversible pulpitis	None	No	12	FP	MTA	5	Success	(M. Sharaan & Ali, 2019)
80	Male	10	36	Carious	Irreversible pulpitis	SAP	Yes	18	FP	MTA	5	Success	(M. Sharaan & Ali, 2019)
81	Female	9	46	Carious	Irreversible pulpitis	None	No	0	FP	MTA	10	Failed	(M. Sharaan & Ali, 2019)
82	Female	50	47	Carious	Reversible pulpitis	None	No	26	PP	Biodentine	5	Success	(Owittayakul & Chuveera, 2016)
83	Female	22	25	Carious	Irreversible pulpitis	SAP	No	12	PP	Biodentine	5	Success	(Owittayakul & Chuveera, 2016)
84	Female	37	14	Carious	Irreversible pulpitis	None	No	12	PP	Biodentine	0	Success	(Owittayakul & Chuveera, 2016)
85	Female	37	36	Carious	Irreversible pulpitis	None	No	12	PP	Biodentine	0	Success	(Owittayakul & Chuveera, 2016)

MP-miniature pulpotomy; PP-partial pulpotomy; FP-full pulpotomy; AAP-asymptomatic apical periodontitis; SAP-symptomatic apical periodontitis; MTA-mineral trioxide aggregate; CEM-calcium enriched cements.

Table 3. Success rate of vital pulp therapy in permanent teeth								
Number	Articles	Age range Age mean	Sample size	Diagnosis	Treatment	Material	Fallow-up (Month)	Success rate
1	(Aravind et al., 2022)	16-35 25.9±4.6	120	Symptomatic irreversible pulpitis Response to vitality tests	FP	WMTA	12	94.7
2	(Linsuwanont et al., 2017)	7-68 29	55	Signs of irreversible pulpitis=45.5% Pain to percussion=43% Presence of radiolucency=38%	FP	MTA	62	87.3
3	(Asgary et al., 2021)	10-60	147	Curiously exposed pulp including Irreversible pulpitis cases	RCT FP	MTA CEM	24	RCT=98% PMTA=100% PCEM=97.9%
4	(Mousavi et al., 2016)	18-30 24	40	Intact teeth of orthodontic patients	DPC MP	Dexamethasone+MTA	2	100
5	(Guan et al., 2021)	6-20 11.75	57	Irreversible pulpitis	DPC PP FP	iRoot BP+	36	DPC=94.4% PP=90.9% FP=84.6% Total=91.2%
6	(Asgary et al., 2013)	-	167	Irreversible pulpitis	VPT RCT	CEM	12	VPT clinical= 97.6% VPT radiographic=92.2% RCT clinical=98.3% RCT radiographic=70.3%
7	(Uyar & Alacam, 2021)	6-13 -	54	Asymptomatic vital pulp	PP	CH MTA Biodentine	12	CH=72.2% MTA=94.4% biodentine=94.4% total=87%

8	(Asgary et al., 2014)	- 31.7	94	Irreversible pulpitis	IDPC DPC MP FP	CEM	12	IDPC=100% DPC=96.4% MP=100% FP=100% Total=98.9%
10	(Verma et al., 2016)	10-16	8	Irreversible pulpitis	FP	MTA	12	100
11	(Kumar et al., 2020)	22-47 30.9±7.3	60	symptomatic vital pulp	FP	Biodentine MTA	1.5	biodentine=82.1 MTA=75.9 total=78.9
12	(Taha & Abdelkader, 2018)	19-69 33.2		Irreversible pulpitis Apical rarefaction was present in 9 teeth	FP	Biodentine	12	Clinical=100% Radiographic=98.4%
13	(Suhag et al., 2019)	15-40	64	Reversible pulpitis	PP	MTA CH	12	MTA=93% CH=69%
14	(Linu et al., 2017)	15-30	26	Reversible pulpitis	PP	MTA Biodentine	18	MTA=84.6% Biodentine=92.3%
15	(Uesrichai et al., 2019)	6-17	67	Irreversible pulpitis	PP	MTA Biodentine	69	MTA=92% Biodentine=87%
16	(Taha et al., 2017)	20-52	46	Irreversible pulpitis	PP	MTA CH	24	MTA=85% CH=43%
17	(Asgary et al., 2018)	26.8±7.6	76	Irreversible pulpitis	PP	CEM	12	91.4%
18	(M. Sharaan & Ali, 2019)	9-13	12	Symptomatic and asymptomatic irreversible pulpitis	FP	MTA	12	100%
19	(Qudeimat et al., 2017)	7-13	13	Irreversible pulpitis and symptomatic apical periodontitis	FP	MTA	24	100%
20	(Taha et al., 2017)	10-59	52	Caries exposure (8 reversible pulpitis, 44 irreversible pulpitis, 14 apical periodontitis)	FP	MTA	24	92.7%

IDPC-indirect pulp capping; DPC-direct pulp capping; MP-miniature pulpotomy; PP-partial pulpotomy; FP-full pulpotomy; MTA-mineral trioxide aggregate; CH-calcium hydroxide; CEM-calcium enriched cements

DISCUSSION

Endodontology is postponing or avoiding non-biological treatment and descending down the restorative spiral, which would significantly reduce the long-term prognosis for tooth retention and function (Verma et al., 2016). Through reviewing medical literature in the past decade, it is revealed that pulpotomy is a minimally-invasive strategy that is cost-effective and has better clinical as well as radiological outcomes compared to other conventional methods (Hakami et al., 2020).

This review aimed to evaluate the clinical and radiographic success rates of vital pulp therapy in permanent teeth which had the signs of reversible and irreversible pulpitis and some of the cases with preapical changes using different pulp capping medicaments. The evidence from the present review of case series and case report studies indicates 98.8% success rate and suggests that permanent teeth diagnosed with irreversible pulpitis can also be effectively treated by vital pulp therapy procedures, including miniature pulpotomy, partial pulpotomy and full pulpotomy which is in agreement with the main finding of a previously-published review that focused mainly on coronal and partial pulpotomy studies (Santos & Pereira, 2021). A pulpotomy is a widely-used technique to treat this type of pulpitis (Hakami et al., 2020). The present review also studied the success rate of vital pulp therapy procedures as an indication to treat permanent teeth with pulpitis.

The success rate for both partial and full pulpotomies with mineral trioxide aggregate and calcium silicate-based cements in the current review was within the range of 84.6%-100% and 78.9%-100%. This suggests that permanent teeth with reversible and irreversible pulpitis can be treated successfully with both coronal and partial pulpotomies, as compared to root canal therapy, which was reported to have a mean success rate of 74.7% (Ghani & Noorani, 2021).

In clinical trials by Asghary et al in 2013 and 2021, the result of clinical and radiologic success rate indicated that vital pulp therapy outcomes can be better than root canal treatment even in teeth with signs of irreversible pulpitis. Asghary et al in 2013 and 2021 Therefore, vital pulp therapy procedures could be a successful alternative treatment modality for root canal treatment (M. E.-S. Sharaan & Abo Elsoud, 2017).

According to the outcome of radiologic high success rate in cases with preapical lesions and other clinical studies, this review shows the repair of preapical radiolucency after vital pulp therapy procedures. Also, some studies noticed radiolucency resolution in addition to complete hard tissue bridge after starting the vital pulp therapy by one year (M. E.-S. Sharaan & Abo Elsoud, 2017).

Material selection is an important factor for successful vital pulp therapy. The results in this review showed a lower success rate in cases which were treated with calcium hydroxide (range=43%-72.2%). This finding is in accordance with a recently randomized controlled trial study that found vital pulp therapy for cariously exposed pulps treated with calcium hydroxide has shown poor outcomes (Uyar & Alacam, 2021). In this review, the success rate ranges of mineral trioxide aggregate, biodentine and calcium-enriched cement were 75.9%-100%, 82.1%-100% and 91.4%-98.9%. the use of these materials in vital pulp therapy indicates better results than traditionally used material calcium hydroxide (Nosrat et al., 2013; Witherspoon, 2008). Mineral trioxide aggregate has a greater long-term sealing ability and stimulates a high quality and a great amount of reparative dentine. In clinical outcomes evaluation, it has demonstrated a high success rate (Witherspoon, 2008).

The coronal seal of the permanent restoration to avoid any bacterial penetration is another important parameter for a long-term success rate of vital pulp therapy. Aa Some researchers affirmed that the coronal seal is more significant than the agent placed in pulpotomy (M. E.-S. Sharaan & Abo Elsoud, 2017).

CONCLUSION

The success rate of vital pulp therapy in 85 permanent teeth in which 81.2% with irreversible pulpitis and in other cases there was reversible pulpitis, was 98.8%. Also, the study of 20 researches showed favourable outcomes of partial and full pulpotomy performed in permanent teeth. So, the vital pulp therapy procedures in permanent teeth even with signs of pulpitis can be more successful, cost-effective and time-saving compared to traditional root canal treatment but further well-designed studies with longer follow-up periods are required to validate these findings.

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