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B.B. Mounes¹,MSc in Conservative and Aesthetic Dentistry,
assistant lecturer of the Conservative and
aesthetic dentistry Department**S.A. Abdullah**²,MSc in Periodontology, assist lecturer
of the Periodontology Department**O.M. Abdulkadhim**¹,MSc in Conservative and Aesthetic Dentistry,
assistant lecturer of the Conservative and
aesthetic dentistry Department

University of Basrah, 61004, Basrah, Iraq

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Б.Б. Мунес¹,магистр консервативной и эстетической
стоматологии, доцент кафедры консерва-
тивной и эстетической стоматологии**С.А. Абдулла**²,магистр пародонтологии, доцент кафедры
пародонтологии**О.М. Абдулкадим**¹,магистр консервативной и эстетической
стоматологии, доцент кафедры консерва-
тивной и эстетической стоматологии

Университет Басры, 61004, Басра, Ирак

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Vital pulp therapy of permanent teeth with symptom of irreversible pulpitis using Bioceramic Putty (One-Fil® PT): A randomized controlled trial

Abstract. Vital pulp therapy aims to preserve the vitality and normal function of the pulp and provides a biologically driven alternative to conventional root canal treatment. Its application in mature permanent teeth with irreversible pulpitis is still under debate, although calcium silicate-based bioceramics have shown promising outcomes. **Objective:** To evaluate the clinical and radiographic outcomes of vital pulp therapy using the One-Fil® bioceramic putty (MEDICLUS, South Korea) in permanent teeth diagnosed with irreversible pulpitis and to analyze the preoperative factors affecting treatment prognosis. **Materials and methods.** A randomized controlled trial was conducted from September 2023 to September 2025 in Basra, Iraq. Thirty-nine patients (40 posterior teeth, aged 13–45 years) underwent partial pulpotomy or full pulpotomy using a One-Fil bioceramic putty. Clinical and radiographic follow-ups were performed at 6, 12, and 24 months. Success was defined as absence of symptoms or radiographic pathosis. **Results.** Thirty-nine teeth were evaluated (recall rate 82%). The overall success rates were 97.4% at 6 months, 92.1% at 12 months, and 89.5% at 24 months. Full pulpotomy showed a higher success rate (95%) than partial pulpotomy (84.2%). Premolars achieved 100% success, whereas molars showed slightly lower outcomes (86.2%). Failures (10.5%) were associated with the molar location, severe preoperative symptoms, and abnormal periapical status. **Conclusion.** Vital pulp therapy with bioceramic putty demonstrated excellent success in mature permanent teeth, including cases of irreversible pulpitis. FP provided superior long-term outcomes compared to PP.

Key words: bioceramic putty, partial pulpotomy, full pulpotomy, vital pulp therapy, irreversible pulpitis

Лечение живой пульпы постоянных зубов с симптомами необратимого пульпита с использованием биокерамической пасты (One-Fil® PT): рандомизированное контролируемое исследование

Реферат. Терапия живой пульпы направлена на сохранение жизнеспособности и нормальной функции пульпы, она представляет собой биологически обоснованную альтернативу традиционному лечению корневых каналов. Ее применение в отношении зрелых постоянных зубов с необратимым пульпитом по-прежнему вызывает споры, хотя биокерамика на основе силиката кальция демонстрирует многообещающие результаты. **Цель** — оценить клинические и рентгенологические результаты лечения с использованием биокерамической пасты One-Fil® (MEDICLUS, Южная Корея) на постоянных зубах с диагнозом «необратимый пульпит» и проанализировать предоперационные факторы, влияющие на прогноз лечения. **Материалы и методы.** Рандомизированное контролируемое исследование проводилось с сентября 2023 года по сентябрь 2025 года в Басре (Ирак). 39 пациентов в возрасте 13–45 лет подверглись частичной или полной пульпотомии (40 моляров) с использованием биокерамической пасты One-Fil. Клиническое и рентгенологическое наблюдение проводили через 6, 12 и 24 месяца. Успех определялся как отсутствие симптомов или рентгенологических патологий. **Результаты.** Было проанализировано 39 зубов (82% повторных осмотров). Общий показатель успешности составил 97,4% через 6 месяцев, 92,1% через 12 месяцев и 89,5% через 24 месяца. Полная пульпотомия продемонстрировала более высокий показатель успешности (95%), чем частичная пульпотомия (84,2%). У премоляров был достигнут 100% успех, тогда как у моляров результаты оказались несколько ниже (86,2%). Неудачи (10,5%) были связаны с расположением моляров, тяжелыми предоперационными симптомами и аномальным периапикальным состоянием. **Заключение.** Терапия живой пульпы с использованием биокерамической пасты продемонстрировала отличные результаты на зрелых постоянных зубах, включая случаи необратимого пульпита. Полная пульпотомия обеспечила более высокие долгосрочные результаты по сравнению с частичной пульпотомией.

Ключевые слова: биокерамическая паста, частичная пульпотомия, полная пульпотомия, терапия живой пульпы, необратимый пульпит

INTRODUCTION

The primary goal of vital pulp therapy (VPT) is to sustain pulp vitality and preserve the remaining tissue, allowing proper structural and functional healing of the pulp–dentin complex. The success of VPT largely depends on maintaining tooth vitality, particularly through adequate blood supply [1].

Preserving vital pulp helps lower the risk of root fractures in affected teeth. In cases of irreversible pulpitis with carious exposure, vital pulp therapy (VPT) can be classified into direct pulp capping (DPC), partial pulpotomy (PP), or full pulpotomy (FP), depending on the extent of pulp removal [2]. In direct pulp capping (DPC), the exposed pulp is directly covered with a capping agent. In PP, a portion of the coronal pulp was removed before placing the capping material, whereas in FP, the entire coronal pulp was removed, and the remaining pulp tissue was sealed with a pulp-capping agent. [1]. Asgary et al. conducted DPC, PP, FP, and indirect pulp capping on mature permanent molars showing clinical signs of irreversible pulpitis, and reported that all four VPT techniques achieved favorable clinical and radiographic outcomes. [3].

Histopathological and histobacteriological evidence indicate that teeth with symptoms of irreversible pulpitis may still be successfully treated with partial or full pulpotomy. However, full pulpotomy is considered to offer a higher likelihood of success as it removes the greatest amount of potentially infected coronal tissue. However, well-defined guidelines for its indications are still lacking [4]. There is a distinction between the use of VPT in immature and mature teeth diagnosed with irreversible pulpitis. In immature teeth, VPT is widely accepted, whereas in mature teeth, supporting evidence remains limited, and its role as a potential alternative to conventional root canal treatment (RCT) is still debated [5]. An ideal pulp-capping material should be biocompatible, exhibit antibacterial and anti-inflammatory effects, provide an effective seal, and promote dentin mineralization [6]. The success of VPT has been closely linked to the introduction of bioceramic materials, such as calcium silicate-based cements, which possess bioactivity, biocompatibility, and sealing ability superior to those of traditional materials such as calcium hydroxide [7].

Among these, bioceramic putty formulations (premixed, ready-to-use) have gained popularity because they simplify handling, reduce the risk of contamination, and support predictable pulp healing [8].

Among these, the One-Fil® bioceramic putty (MEDICLUS, South Korea) has been introduced as a premixed, ready-to-use calcium silicate-based material. Its putty consistency facilitates single-step (“one-fill”) placement, minimizing handling errors, and reducing contamination risk. Clinical studies have reported favorable outcomes when using bioceramic putty for pulpotomy in mature permanent teeth with irreversible pulpitis, with success rates comparable to or higher than conventional RCT [8]. This finding supports its use as a biologically based, minimally invasive treatment modality that preserves pulp vitality, tooth biomechanics, and proprioception.

This study aimed to assess the clinical and radiographic results of VPT in permanent teeth with irreversible caries-induced pulpitis using bioceramic putty (one fill) for 6, 12, and 24 months and to analyze the preoperative factors influencing VPT prognosis.

MATERIAL AND METHODS

Study design

The study was a randomized, controlled trial comparing the success of vital pulp therapy treatment (partial pulpotomy, full pulpotomy) using bioceramic putty (One-Fil® Putty, MEDICLUS, Korea) for 6, 12, and 24 months in permanent teeth of 13–45-year-olds presenting with vital (detected by clinical signs/symptoms) posterior permanent teeth characterized by “cases with a history of pain or symptoms classically suggestive of irreversible pulpitis, according to AAE diagnostic criteria” and carious pulp exposure at two private clinics (Batool Dental Clinic and Al Basra Clinic) in Basra, Iraq, by one operator from September 2023 to September 2025. Patients were invited to participate in this study after being contacted via phone. They were all briefed on the treatment process, materials used, any possible side effects, planned follow-up appointments, and the possibility of RCT as a backup plan in the event that the treatment did not work.

Clinical inclusion criteria: Patient presented with deep caries, clinical signs, and symptoms of irreversible pulpitis; could be restored with stainless-steel crowns (SSC) or resin composites; no unusual swelling or mobility is observed; vital pulp, indicated by a bright red appearance with bleeding from the exposure site, that was profuse but controllable within 5 min. Radiographic inclusion criteria: Carious lesions extending into at least three-quarters of the inner dentin thickness; the absence of significant radiolucency in the periapical or furcation areas; absence of calcifications, pulp canal obliteration, internal resorption, or pathological external root resorption.

Clinical exclusion criteria: Uncontrolled bleeding from the pulp exposure site after 5 min.; pulp tissue appeared necrotic, as evidenced by the lack of bleeding or pale necrotic tissue. Radiographic exclusion criteria: Presence of distinct radiolucency in the furcation or periapical regions; evidence of internal resorption, pathologic external resorption, calcification, or pulp canal obliteration.

Treatment protocol

One operator performed all the treatments while adhering to stringent aseptic procedures and using a rubber dam. Following local anesthesia with 2% mepivacaine hydrochloride and 1: 100,000 adrenaline (Scandonest 2%; Septodont, France), a slow-speed round steel bur was used to remove caries, and a high-speed round diamond bur was used to prepare the cavity. After pulp exposure, 2.5% sodium hypochlorite was used to irrigate the cavity. A sterile high-speed round carbide bur was used to remove at least 2–3 mm of pulp tissue beneath the exposure site if the pulp exposure satisfied the inclusion criteria. This process was repeated until only healthy pulp tissue remained. If inflammation was present, complete pulp removal was performed

at the level of the canal orifices, and the end of the procedure was judged by the appearance of the reaming tissue. If bleeding did not stop within 5 min, the treated tooth was removed from the study and treated with root canal treatment.

The teeth were then restored with permanent restorations, and the color and amount of bleeding persisted. The pulpal tissue was irrigated with 10 mL of 2.5% sodium hypochlorite solution, and bleeding was controlled with 2.5% sodium hypochlorite-soaked cotton pellets. After amputation of the inflamed pulp, hemostasis was achieved using a cotton pellet soaked in 2.5% NaOCl for 2 min and was repeated if necessary.

Less than 5 min in teeth that were treated with partial pulpotomy, place 1–1.5 mm One-Fil® Bioceramic Putty (MEDICLUS, South Korea) on the exposed pulp tissue and surrounding dentin (20 teeth). If bleeding continued for more than 5 min, complete pulp removal was achieved (complete pulpotomy, 19 teeth) to the canal orifice; after that, a 2 mm thickness of putty bioceramic was placed in the chamber, and then all partial and complete pulpotomies were performed with a resin-modified glass ionomer liner (3M-ESPE, Germany) that covered all the putty bioceramic material, after which the composite material was placed as a bulk-fill composite. Postoperative periapical radiographs were obtained following permanent restoration placement. A rigorous aseptic protocol was maintained during all the restoration procedures to prevent any risk of recontamination.

Follow-up protocol and outcome assessment

Clinical and radiographic evaluations were conducted 6, 12, and 24 months postoperatively, although not all patients attended every follow-up. Outcomes were assessed based on clinical and radiographic criteria and were considered successful if:

- No clinical signs or symptoms of pulpal disease, including pain, tenderness to percussion, excessive mobility, sinus tract, or swelling, were observed. Teeth exhibited normal mobility and a positive response to tests, such as the absence of spontaneous (persistent) pain, lack of tenderness to percussion (palpation), no signs of pathologic mobility (swelling), radiographic evidence of continued root development (in immature teeth), or absence of periapical/furcal radiolucency, and electric pulp testing, indicating healthy and uninfamed pulp.
- Follow-up radiographs showed no evidence of pathology such as root resorption or periapical radiolucency. The integrity of the coronal restoration was assessed, and repairs were performed if necessary.

Data collection

Preoperative data and observations pertaining to the course of treatment were collected from patient records. Age, sex, tooth

type and location, stage of root development, clinical signs and symptoms, percussion test results, pulp and periapical diagnoses, and evaluations from preoperative radiographs were among the preoperative data recorded. Treatment observations recorded included bleeding time and the type of restoration performed.

Statistical analysis

The baseline characteristics of the included cases were analyzed using descriptive statistics and were expressed as frequencies and percentages. Differences in categorical variables (age group, preoperative diagnosis, periapical status, type of vital pulp therapy, and tooth position) were assessed using Fisher's exact test owing to the relatively small and unbalanced sample sizes. Success rates, as well as the overall failure rates, were compared across subgroups. For continuous variables, independent sample t-tests were planned; however, no continuous outcomes were available in the present dataset. The level of statistical significance was set at $p < 0.05$, and 95% confidence intervals were reported where appropriate.

RESULTS

From 2023 to 2025, 39 patients with 40 permanent teeth with carious pulp exposure were treated with One-Fil® Bioceramic Partial and full pulpotomy. 38 patients with 39 teeth attended the follow-up examination. The recall rate was 82%. The recall period varied from 6 to 14 months (median 12 months). In this study, 34 out of 39 treated teeth were classified as successful, representing a success rate of 89.5%, while failure was observed in 4 teeth (10.5%; table 1).

As treatments were not performed simultaneously for all patients, follow-up periods were calculated as the average across cases. The success rates at 6, 12, and 24 months were 97.4%, 92.1%, and 89.5%, respectively. The patients' ages ranged from 13 to 45 years, with a mean of 35 years (median=16 years). The treated tooth population included teeth with complete root formation (97.4%), preoperative pain (97.4%), radiolucency due to incomplete root closure (2.6%), and clinical signs of irreversible pulpitis (97.4%).

Table 1. Descriptive statistics of treatment outcomes by clinical factors

Factor	Subgroup	n		Success						Failure overall	
				6 months		12 months		24 months			
		abs.	%	abs.	%	abs.	%	abs.	%	abs.	%
Age, years	13–30	15	38.5	15	100.0	15	100.0	14	93.3	1	6.7
	31–45	24	61.5	23	95.8	23	95.8	22	91.7	3	12.5
Preop. diagnosis	Reversible	1	2.6	1	100.0	1	100.0	1	100.0	0	0
	Irreversible	38	97.4	37	97.4	35	92.1	34	89.5	4	10.5
Periapical status	Normal	38	97.4	37	97.4	35	92.1	34	89.5	3	7.9
	Abnormal	1	2.6	1	100.0	1	100.0	1	100.0	1	100.0
VPT treatment	PP	19	48.7	19	100.0	18	94.7	16	84.2	3	15.8
	FP	20	51.3	20	100.0	19	95.0	19	95.0	1	5.0
Tooth position	Premolar	10	25.6	10	100.0	10	100.0	10	100.0	0	0
	Molar	29	74.4	28	96.6	26	89.7	25	86.2	4	13.8

Table 2. Inferential statistics (Fisher's exact test) for associations between clinical factors and outcomes

Factor	Success			Overall failure
	6 months	12 months	24 months	
Age	1.000	1.000	1.000	0.646
Preoperative diagnosis	1.000	1.000	1.000	1.000
Periapical status	1.000	1.000	1.000	0.238
VPT treatment	1.000	1.000	0.597	0.598
Tooth position	1.000	0.555	0.537	0.287

Descriptive data and univariate analyses (Fisher's exact test of the relationship between each factor and the outcomes of vital pulp treatment) are shown in table 2.

Cases with a diagnosis of reversible pulpitis ($n=1$) showed complete success throughout the 24-month follow-up period, while irreversible pulpitis cases demonstrated a slightly lower success rate (89.5% at 24 months).

Teeth with normal periapical tissues demonstrated superior outcomes compared with those with periapical changes. While the majority of "normal" cases maintained high success (89.5% at 24 months), the single abnormal case failed over time. Examples of successful cases are shown in fig. 1.

Full pulpotomy outperformed partial pulpotomy, with a 95% success rate at 24 months compared with 84.2%

for PP. Premolars demonstrated a 100% success rate at all follow-up intervals, while molars showed slightly reduced success (86.2% at 24 months).

Patients reporting no or mild pain showed excellent long-term outcomes, whereas those with moderate/severe responses demonstrated higher failure rates, although they were still favorable overall. Both complete and incomplete root development cases showed high survival rates, although the single immature root case failed by 24 months. All cases demonstrated a bleeding time < 5 min; none exceeded 5 min. The outcomes were consistently favorable in this group. All cases with satisfactory restorations demonstrated high survival, whereas no unsatisfactory restorations were recorded.

Preoperatively, most teeth exhibited moderate pain (50%), followed by mild pain (25%) and severe pain (22.5%), while only one tooth (2.5%) was asymptomatic. Postoperatively, 39 teeth (97.5%) were pain-free, whereas one tooth (2.5%) developed severe pain and subsequently failed. No cases reported mild or moderate postoperative pain. The relationship between preoperative pain and postoperative pain is shown in fig. 2.

These baseline variables demonstrated little or no variation, and were therefore presented descriptively only. Because of this high degree of homogeneity, these variables were not included in the inferential statistical analysis in table 2.

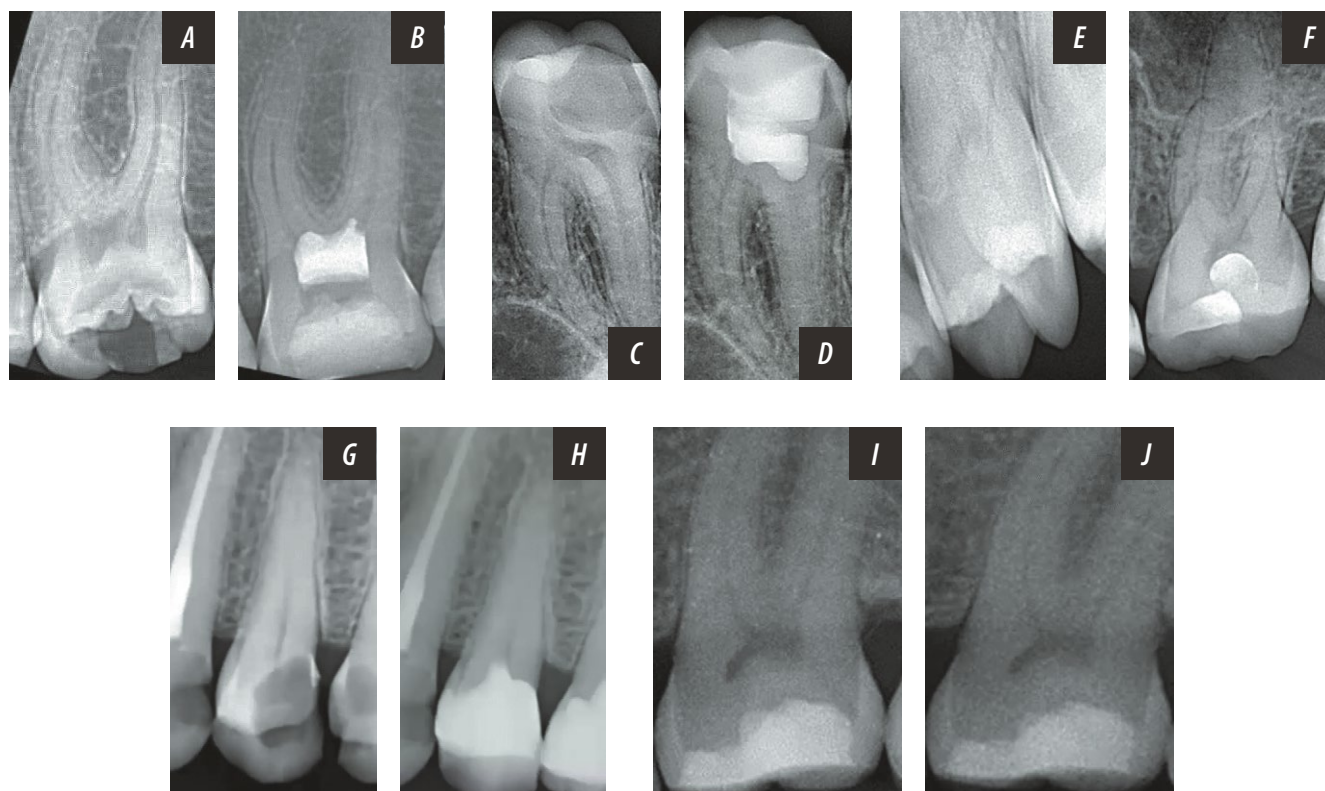


Fig. 1. Partial and full pulpotomy procedures were performed using Putty One Fill bioceramic cement in patients with symptoms of irreversible pulpitis. Upper right second molar in a 16-year-old female: A — preoperative periapical radiograph; B — one-year follow-up radiograph showing complete pulp healing and formation of a dentinal bridge. Lower right first molar in a 17-year-old female patient: C — preoperative periapical radiograph; D — two-year follow-up radiograph showing a complete dentinal bridge after full pulpotomy. Upper left second premolar

in a 22-year-old male patient: E — preoperative periapical radiograph; F — two-year follow-up radiograph showing a thick dentinal bridge after partial pulpotomy. Upper right first and second premolars in a 29-year-old female patient: G — preoperative periapical radiograph; H — two-year follow-up radiograph after full pulpotomy. Upper left second molar in a 22-year-old male patient: I — preoperative periapical radiograph; J — one-year follow-up radiograph showing a thick dentinal bridge after partial pulpotomy

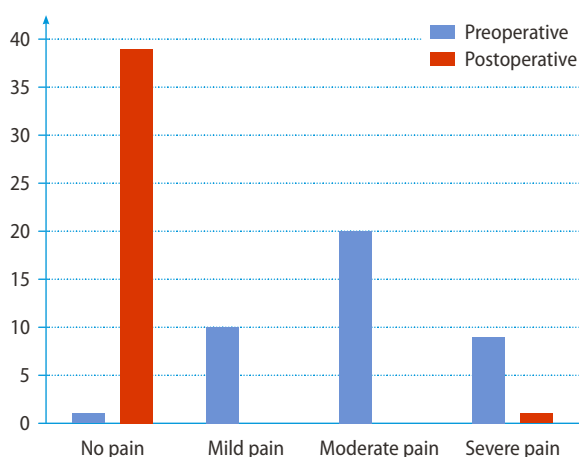


Fig. 2. Pain levels in patients before and two years after vital pulp therapy

However, descriptive trends indicate (table 3):

- Slightly better outcomes were observed in younger patients, premolars, and full pulpotomy (FP).
- Higher failure rates were observed in molars and partial pulpotomy (PP).

Analysis of the failed cases revealed several noteworthy trends. Overall, the characteristics of unfavorable outcomes suggest that preoperative spontaneous pain, positive percussion response, and molar location could be linked to a higher chance of failure, although statistical analysis in the overall cohort did not yield significance, as shown in table 4.

DISCUSSION

Pulpitis, resulting from deep dental caries, is a common issue in dental practice. Compared to conventional root canal treatment, vital pulp therapy can substantially reduce treatment time and costs, while enhancing the long-term survival of affected teeth [4].

Advancements in pulp-capping materials, aseptic techniques, and microscopic magnification have enabled many recent studies to report successful outcomes of VPT in vital teeth with carious pulp exposure, even in cases presenting signs and symptoms of irreversible pulpitis and apical periodontitis [9]. Vital pulp therapy offers a more

conservative and tailored approach for the management of pulpitis. There are four types of VPT: indirect pulp capping (IPC), direct pulp capping (DPC), partial pulpotomy (PP), and full pulpotomy (FP). In this study, IPC and DPC were excluded because IPC does not involve pulp exposure, and DPC did not meet the inclusion criteria [4].

This randomized controlled trial tested VPT techniques for treating carious permanent posterior teeth with reversible or irreversible pulpitis and found a 93% success rate ($p=1.000$). No significant differences were observed in the clinical or radiographic outcomes between the two VPT approaches. The high success rate of the materials and techniques used suggests that VPT may be used to manage deep caries in symptomatic mature permanent teeth, rather than conventional RCT. Each VPT procedure offers distinct advantages and limitations that can guide practitioners in selecting their preferred treatment approach. From the patient's perspective, successful treatment alleviates the clinical symptoms and ensures long-term tooth retention. For researchers and healthcare providers, an ideal outcome includes not only disease resolution, but also preservation of pulp function. This study demonstrated that teeth traditionally treated with complete pulp extirpation due to carious pulp exposure could be successfully managed with vital pulp therapy. This suggests that periapical health at baseline

Table 3. Comparative trends in success rates by clinical factors

Factor	Subgroup	Success 24 moths, %	Overall failure, %	Observed trend
Age, years	13–30	93.3	6.7	Slightly higher success compared to older group
	31–45	91.7	12.5	Slightly more failures observed
Tooth position	Premolar	100.0	0	Highest long-term success
	Molar	86.2	13.8	Lower success compared to premolars
VPT treatment	FP	95.0	5	Better outcomes than PP
	PP	84.2	15.8	More failures compared with FP
Preop. diagnosis	Reversible	100.0	0	Limited data ($n=1$)
	Irreversible	89.5	10.5	Slightly lower long-term success
Periapical status	Normal	89.5	7.9	Good overall outcomes
	Abnormal	100.0	100.0	Only one case, not representative

Table 4. Demographic and clinical features of teeth with unsuccessful outcomes

Tooth	Age	Preoperative symptom	Percussion	Periapical state	Time to detect failure	Observation of failed cases
Maxillary first molar	29	Spontaneous pain	Positive	Normal	1 week	Pain
Mandibular second molar	13	Spontaneous pain with swallowing	Positive	Radiolucency around completed root	12 month	Pain + periapical lesion
Mandibular first molar	32	Sensitivity to cold drink	Positive	Normal	24 month	Pain
Maxillary second molar	35	Lots of follow up	Not detected		Inaccessible to follow up after 12 months	

remains a critical determinant of treatment outcome, likely due to the reduced bacterial burden and improved healing environment.

This study evaluated the clinical outcomes of VPT in permanent teeth and examined the influence of various demographic, diagnostic, and intraoperative factors on the treatment prognosis. Overall, VPT achieved high success rates at 6 and 12 months, with a slight decline at 24 months. These findings support the increasing body of evidence that VPT is a predictable biological alternative to root canal treatment, even in cases traditionally classified as having irreversible pulpitis. These findings add to the growing body of evidence supporting full pulpotomy in mature permanent teeth, as it ensures complete removal of inflamed coronal pulp tissue while preserving radicular vitality. Nevertheless, both techniques demonstrated encouraging results, highlighting the flexibility of the VPT approaches.

Younger patients (13–30 years) demonstrated a slightly higher long-term survival than older patients (31–45 years). This trend aligns with biological principles, as younger pulp tissue has greater vascularity and regenerative potential [10]. “Although statistical significance was not achieved, the findings support the view that age contributes to pulp-healing capacity.”

Preoperative diagnosis, whether reversible or irreversible pulpitis, was not found to be a determinant factor of the outcome in this cohort. This supports the growing body of evidence challenging the traditional view that irreversible pulpitis necessitates RCT. Several recent randomized controlled trials and systematic reviews have confirmed that full pulpotomy in mature permanent teeth with irreversible pulpitis can yield success rates comparable to those of RCT, particularly when bioactive materials are used [11].

A single case of reversible pulpitis achieved complete success, while irreversible pulpitis cases showed slightly lower outcomes (89.5% at 24 months). These results agree with those of studies showing favorable outcomes of VPT even in irreversible pulpitis [3, 12]. Importantly, percussion testing appeared to correlate with prognosis: teeth with mild or no percussion pain had excellent survival, while those with moderate-to-severe responses showed higher failure rates. This observation is consistent with the hypothesis that the severity of preoperative symptoms reflects the degree of pulpal inflammation, and thus influences healing [10].

Periapical status and root development. Most successful cases had normal periapical tissues at baseline, whereas only teeth with abnormal periapical status failed. Similar findings have been reported in [13], who emphasized the importance of intact periapical health for favorable outcomes. Interestingly, three failed cases initially presented with a normal periapical status, suggesting that periapical health alone is not a sufficient predictor. With respect to root development, a single immature case failed, highlighting the need for larger studies before firm conclusions can be drawn.

The periapical status showed minimal impact on prognosis, although the single case with preoperative radiolucency ultimately failed, aligning with reports that periapical pathology may lower VPT success rates, albeit not significantly, if proper sealing and bioactive materials are employed [10].

Intraoperative factors. All patients achieved hemostasis within 5 minutes, which is an important prognostic indicator. Studies have shown that prolonged bleeding reflects deeper pulpal inflammation and poorer outcomes [14]. Treatment type also influenced the results; full pulpotomy (FP) demonstrated superior survival compared with partial pulpotomy (PP). These findings support systematic reviews showing that FP improves long-term outcomes in mature permanent teeth [15]. The ability of FP to remove the entire inflamed coronal pulp while preserving radicular vitality may explain its superior performance.

The type of restorative procedure and quality of the coronal seal appear to be critical to treatment longevity. All cases with satisfactory restorations maintained higher success rates, whereas compromised sealing has been consistently identified as a key factor for failure in systematic reviews and meta-analyses [11].

Importantly, postoperative pain was minimal in almost all cases, reflecting the effectiveness of modern bioactive pulp-capping materials in reducing inflammation and supporting pulp vitality. This is consistent with clinical trials using calcium silicate-based cements, such as Biodentine, and iRoot BP Plus, which have shown predictable success in both immature and mature teeth [10]. Tooth position and morphology. Premolars demonstrated perfect survival, while molars showed slightly reduced outcomes. This difference has been attributed to the complex anatomy of molars and higher functional stresses [3]. “Nonetheless, the high overall success in molars underscores the applicability of VPT to posterior teeth when proper case selection and techniques are followed.” Overall, the present findings strengthen the paradigm shift in endodontics to preserve pulp vitality, whenever feasible. VPT, when combined with careful case selection, adequate hemostasis, and high-quality coronal sealing, represents a reliable biologically oriented alternative to conventional root canal therapy for managing carious pulp exposure in permanent teeth.

The findings of this study emphasize that VPT is broadly effective in a variety of clinical scenarios. While inferential analysis showed no statistically significant differences, despite the observed trends of success, descriptive trends suggest that younger patients, premolars, normal periapical status, and full pulpotomy may be associated with better long-term outcomes, which is consistent with the growing acceptance of VPT as a viable alternative to root canal therapy in permanent teeth [12, 15].

Interestingly, in table 4, three of the failed cases initially demonstrated a normal periapical status, indicating that periapical changes at baseline are not the sole determinant of treatment prognosis. The variable time to failure (ranging from one week to two years) highlights that both early and late failures are possible. Importantly, the patient with preoperative periapical radiolucency progressed to a periapical lesion, supporting the view that compromised periapical health remains a significant risk factor. Overall, the characteristics of unfavorable outcomes suggest that preoperative spontaneous pain, positive percussion response, and molar location may be associated with a high risk of failure, although statistical analysis in the overall cohort did not yield significance.

Recently, several systematic reviews and meta-analyses on VPT for irreversible pulpitis published [16–18]. A comprehensive review concluded that FP and PP are effective treatments for teeth diagnosed with symptomatic irreversible pulpitis (SIP), with success rates comparable to those for normal pulp or reversible pulpitis. The study emphasized the importance of hemostasis within six minutes and the use of calcium silicate-based materials for optimal outcomes [16]. A meta-analysis demonstrated that DPC is a viable treatment option for irreversible pulpitis, with an overall success rate of approximately 95%. However, the authors noted a need for more rigorous studies to confirm these findings [17]. However, various VPT techniques utilizing materials such as mineral trioxide aggregate (MTA) and other pulp-protecting agents (PPAs) are effective in managing irreversible pulpitis in both mature and immature permanent teeth. Calcium hydroxide was found to be less favorable than MTA and other PPAs [18].

Contextualize FP within the spectrum of VPT to discuss FP as part of a continuum of VPT options, including PP and DPC, and their respective success rates in treating irreversible pulpitis. Highlight material considerations to emphasize the role of materials such as MTA and calcium silicate-based cements in enhancing the success of VPT procedures. Finally, we acknowledge the limitations and areas for future research

to note the need for further studies with larger sample sizes and standardized methodologies to strengthen the evidence base for FP and other VPT techniques.

LIMITATIONS AND FUTURE RESEARCH

The small sample size in certain subgroups (e.g., reversible pulpitis, immature root development) reduced the statistical power and may explain the lack of significant associations. Furthermore, the follow-up period was limited to two years. Future multicenter studies with larger sample sizes and longer observation periods are necessary to confirm the identified trends and better define the role of clinical predictors in VPT outcomes.

CONCLUSION

VPT has demonstrated excellent overall success in mature permanent teeth, including cases of irreversible pulpitis. Failures were most often associated with the molar location, severe preoperative symptoms, and abnormal periapical status.

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REFERENCES:

1. Suresh S., Kalhor F.A., Rani P., Memon M. Assessing the success of a mineral trioxide aggregate and a pre-mixed bioceramic in mature teeth with irreversible pulpitis with full pulpotomy: A randomized clinical trial. *Clin Exp Dent Res*. 2025; 11 (1): e70090. [PMID: 39973665](#)
2. Guan X., Zhou Y., Yang Q., Zhu T., Chen X., Deng S., Zhang D. Vital pulp therapy in permanent teeth with irreversible pulpitis caused by caries: A prospective cohort study. *J Pers Med*. 2021; 11 (11): 1125. [PMID: 34834477](#)
3. Asgary S., Hassanizadeh R., Torabzadeh H., Eghbal M.J. Treatment outcomes of 4 vital pulp therapies in mature molars. *J Endod*. 2018; 44 (4): 529–535. [PMID: 29397215](#)
4. Zhang N., Kang Q., Cheng Y. Pulpotomy for teeth with irreversible pulpitis in immature permanent teeth: a retrospective case series study. *Sci Rep*. 2024; 14 (1): 6395. [PMID: 38493190](#)
5. Santos J.M., Pereira J.F., Marques A., Sequeira D.B., Friedman S. Vital pulp therapy in permanent mature posterior teeth with symptomatic irreversible pulpitis: A systematic review of treatment outcomes. *Medicina (Kaunas)*. 2021; 57 (6): 573. [PMID: 34205149](#)
6. Saghir M.A., Asatourian A., Garcia-Godoy F., Sheibani N. Effect of biomaterials on angiogenesis during vital pulp therapy. *Dent Mater J*. 2016; 35 (5): 701–709. [PMID: 27546854](#)
7. Sarshari M.G., Shakeri K., Parhizkar A. Effect of vital pulp therapy biomaterials on tooth discolouration: A review of the literature. *Int J Biomater*. 2025; 2025: 3080084. [PMID: 40400897](#)
8. Ghaly M.S., Abozena N.I., Ghouraba R.F., Kabbash I.A., El-Desouky S.S. Clinical and radiographic evaluation of premixed bioceramic putty as an apical plug in nonvital immature anterior permanent teeth. *Sci Rep*. 2025; 15 (1): 26487. [PMID: 40691703](#)
9. Sriudomdech P., Santiwong B., Linsuwanont P. Outcomes of vital pulp treatment in permanent teeth with carious pulp exposure with signs and symptoms of irreversible pulpitis. *Clin Oral Investig*. 2024; 28 (10): 551. [PMID: 39320508](#)
10. Ricucci D., Loghin S., Siqueira J.F. Jr Correlation between clinical and histologic pulp diagnoses. *J Endod*. 2014; 40 (12): 1932–9. [PMID: 25312886](#)
11. Komora P., Vámos O., Gede N., Hegyi P., Kelemen K., Galvács A., Varga G., Kerémi B., Vág J. Comparison of bioactive material failure rates in vital pulp treatment of permanent matured teeth - a systematic review and network meta-analysis. *Sci Rep*. 2024; 14 (1): 18421. [PMID: 39117767](#)
12. Zanini M., Meyer E., Simon S. Pulp inflammation diagnosis from clinical to inflammatory mediators: A systematic review. *J Endod*. 2017; 43 (7): 1033–1051. [PMID: 28527838](#)
13. Aguilar P., Linsuwanont P. Vital pulp therapy in vital permanent teeth with cariously exposed pulp: a systematic review. *J Endod*. 2011; 37 (5): 581–7. [PMID: 21496652](#)
14. Taha N.A., Khazali M.A. Partial pulpotomy in mature permanent teeth with clinical signs indicative of irreversible pulpitis: A randomized clinical trial. *J Endod*. 2017; 43 (9): 1417–1421. [PMID: 28673494](#)
15. Cushley S., Duncan H.F., Lappin M.J., Tomson P.L., Lundy F.T., Cooper P., Clarke M., El Karim I.A. Pulpotomy for mature carious teeth with symptoms of irreversible pulpitis: A systematic review. *J Dent*. 2019; 88: 103158. [PMID: 31229496](#)
16. Coll J.A., Dhar V., Guelmann M., Crystal Y.O., Chen C.Y., Marghalani A.A., AlShamali S., Xu Z., Glickman G., Ather A., Sabeti M., Wedeward R. Vital pulp therapy in permanent teeth: A systematic review and meta-analyses. *Pediatr Dent*. 2025; 47 (3): 137–150. [PMID: 40533920](#)
17. Ruiz-González P., Cabanillas-Balsera D., Saúco-Márquez J.J., Segura-Egea J.J. Outcome of direct pulp capping in teeth diagnosed as irreversible pulpitis: Systematic review and meta-analysis. *J Clin Exp Dent*. 2022; 14 (7): e594–e603. [PMID: 35912026](#)
18. Asgary S., Shamszadeh S., Shirvani A. Management strategies for pulpitis in vital permanent teeth in children and adolescents: a systematic review and meta-analysis of randomized clinical trials. *Eur Arch Paediatr Dent*. 2025; 26 (3): 451–463. [PMID: 40117109](#)