



CODEN [USA]: IAJPBB

ISSN : 2349-7750

**INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES**

SJIF Impact Factor: 7.187

<https://doi.org/10.5281/zenodo.8079847>Available online at: <http://www.iajps.com>

Research Article

**VITAL PULP THERAPY OF MATURE PERMANENT TEETH
WITH IRREVERSIBLE PULPITIS FROM THE PERSPECTIVE
OF PULP BIOLOGY****¹Dr. Nowaira Ibrar, ²Dr Ammad Ashfaq, ³Dr Rida Batool, ⁴Dr Hafiza Areej Gul Qaisar,
⁵Dr Kinza Qureshi**¹21828-D, nirv1995@gmail.com, ²742934-03-D, ³PMDC No : 721377-01-D, ⁴22484-D,
⁵722384-03-D**Abstract:**

Background: When irreversible pulpitis is detected in a tooth, root canal therapy (RCT) is commonly conducted to fully eliminate the pulp tissue, which could potentially increase the chances of vascularity loss and make the teeth more susceptible to fractures. Vital pulp therapy (VPT) is an individualized approach for treating irreversible pulpitis that aligns with the current trend of marginally aggressive endodontics. Nonetheless, there is currently a lack of well-defined criteria for determining when VPT should be recommended.

Aim: In this study, a prospective cohort design was employed to assess the results of utilizing iRoot BP Plus for vital pulp therapy (VPT) in permanent teeth of patients aged 5 to 19 years who had irreversible pulpitis due to dental caries. Additionally, the study examined the preoperative factors that influenced the prognosis of VPT.

Methods:

A total of 65 patients, each with a single permanent tooth affected by irreversible pulpitis caused by dental caries, received vital pulp therapy using iRoot BP Plus. Generally overall participants underwent VPT following the standardized protocol. Prior to the procedure, informed consent was obtained, and teeth remained isolated using the dental dam. Skilled operators achieved VPT using iRoot BP Plus, followed by tooth restoration using either composite resin or stainless-steel crowns. Feed-back appointments were scheduled at 3, 6, and 12 months postoperatively, and subsequently on an annual basis. The success of the treatment was determined through a comprehensive assessment, combining medical and radiographic assessments.

Results: Upon completion of a follow-up period ranging from 5 to 42 months, a total of 59 teeth belonging to 65 patients were available for assessment. The subjects had a mean age of 11.76 ± 4.82 years. The complete success rate of vital pulp therapy, as determined through clinical and radiographic evaluations, was 92.3% (51 out of 65 cases). When considering an opinion period of one year or more, achievement rate remained high at 91.6% (39 out of 48 cases). Notably, none of signs or physical examination results had an important impact on the prognosis of VPT, as confirmed by a binary logistic regression model ($p > 0.06$).

Conclusion: Vital pulp therapy using iRoot BP Plus has demonstrated successful outcomes when utilized for the treatment of irreversible pulpitis produced through dental caries in patients ranging from 5 to 19 years of age with permanent teeth.

Keywords: Root Canal Therapy, Irreversible Pulpitis, Vital Pulp Therapy.

Corresponding author:**Dr. Nowaira Ibrar,**
21828-D,
nirv1995@gmail.com

QR code



Please cite this article in press Nowaira Ibrar et al, Vital Pulp Therapy Of Mature Permanent Teeth With Irreversible Pulpitis From The Perspective Of Pulp Biology., Indo Am. J. P. Sci, 2023; 10 (06).

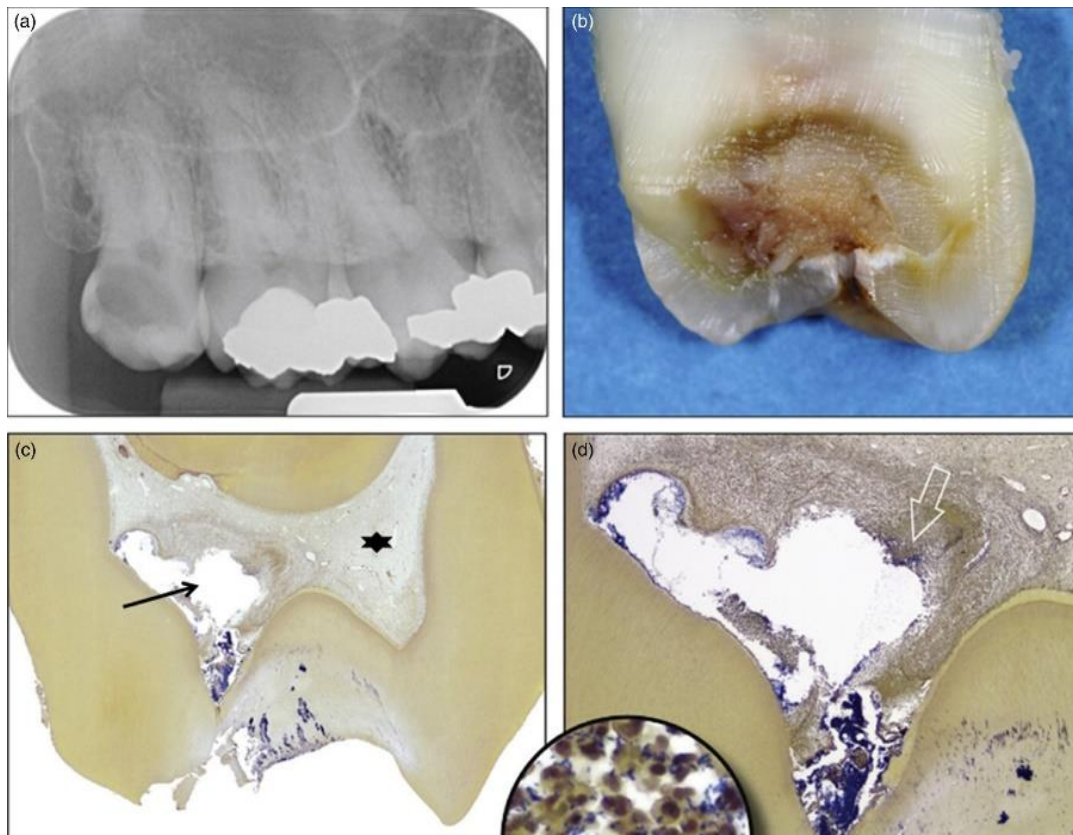
INTRODUCTION:

In the conventional notion, irreversible pulpitis is diagnosed when inflammation of the pulp reaches a specific level, and the standard approach is to perform RCT to completely eliminate the pulp tissue. However, RCT may lead to reduced blood supply, rendering the tooth more susceptible to fracturing [1]. Despite being the established treatment, long-standing success rate of treated teeth following RCT is meaningfully lesser compared to untreated teeth, particularly in molars [2-4]. This discrepancy could be attributed to the fact that vital teeth, which possess more soft and hard tissues, exhibit greater resilience to normal biting forces. To preserve a greater amount of healthy tissue associated to RCT, vital pulp therapy is very auspicious individualized therapy option for irreversible pulpitis. VPT involves the partial removal of pulp based on its condition [5].

VPT has emerged as a promising treatment modality for mature permanent teeth with irreversible pulpitis.

Irreversible pulpitis refers to a condition where the pulp tissue within a tooth becomes inflamed to an extent that it is unable to recover and heal spontaneously [6]. Traditionally, RCT was the main standard approach for managing irreversible pulpitis, involving whole elimination of the affected pulp tissue [7]. However, RCT has been associated with certain drawbacks, such as a potential decrease in vascularity and an improved danger of tooth fracture [8]. The long-standing preservation rate of teeth following RCT has been found to be significantly lower compared to vital teeth, particularly in molars [9]. This discrepancy can be attributed to the fact that vital teeth, which retain both the soft and hard tissues of the pulp, exhibit a greater confrontation to occlusal forces inside physiological range. Consequently, there has been a growing interest in exploring alternative treatment options that aim to preserve more of the natural tooth structure and maintain its functionality [10].

Image 1:

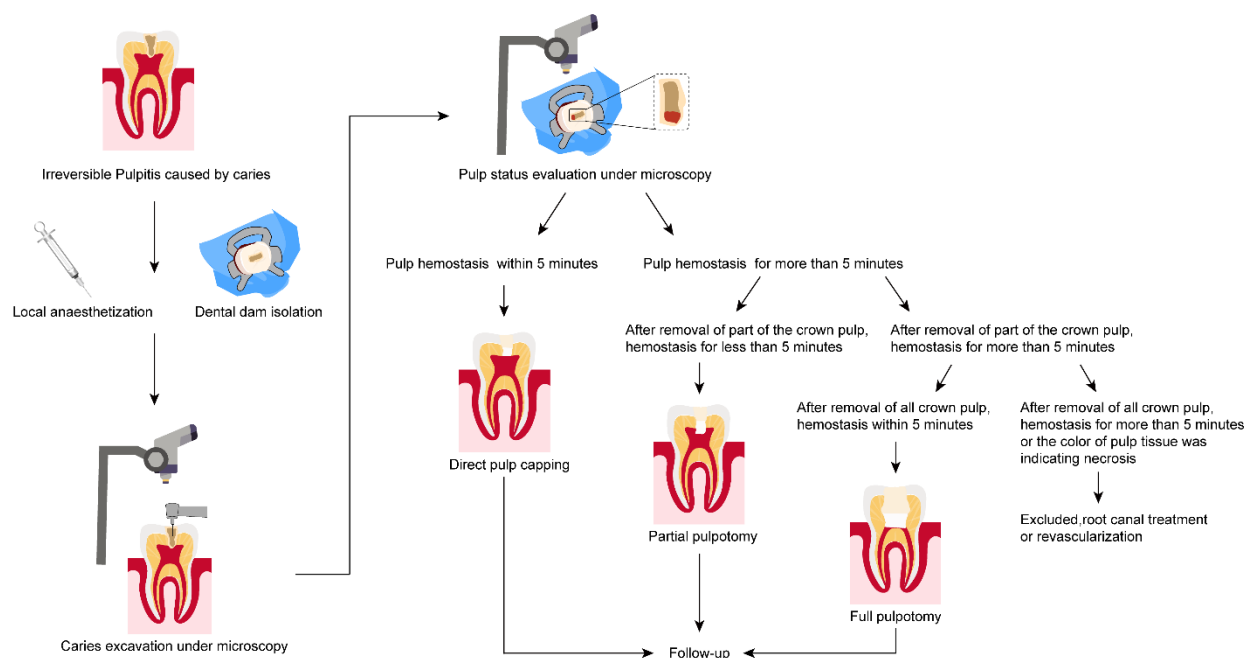


VPT involves a personalized approach that aims to remove only a certain amount of pulp tissue based on its condition, allowing for the preservation of healthy pulp and dentin. By selectively removing the inflamed or necrotic pulp, VPT seeks to promote the regeneration and healing of the remaining pulp tissue [11]. This approach takes into consideration the knowledge that even mature permanent teeth can maintain vitality and continue to provide important functions when managed appropriately [12]. In recent years, various VPT techniques, such as partial pulpotomy and regenerative endodontic procedures, have shown promising outcomes in preserving the vitality and functionality of mature permanent teeth having irreversible pulpitis [13]. These techniques aim to not only alleviate pain and inflammation but also promote tissue repair and regeneration, ultimately enhancing the long-term prognosis of the affected teeth. This review aims to explore the concept of VPT in context of mature permanent teeth having irreversible pulpitis, highlighting its advantages, limitations, and clinical applications. By understanding the principles and evidence behind VPT, dental practitioners can make informed decisions regarding the most appropriate treatment approach for their patients, considering both the

individual's pulpal status and the long-term preservation of the affected teeth [14].

The ideal characteristics of pulp-capping agents include being non-toxic, possessing antibacterial and anti-inflammatory properties, having good sealing capabilities, and the ability to promote dentin mineralization. A relatively new bio ceramic material called iRoot BP Plus, developed by Innovative Bio ceramics in Vancouver, BC, Canada, has demonstrated similar efficacy to MTA in dog teeth pulpotomy procedures. Moreover, iRoot BP Plus exhibits superior clinical handling performance compared to MTA [15]. This study has indicated that iRoot BP Plus exhibits favorable biocompatibility, along with the capacity to encourage mineralization and odontoblast difference. As a result, this is considered a viable alternative to calcium hydroxide for pulpotomy procedures in permanent teeth. iRoot BP Plus holds promising potential for medical request just like the pulp-capping agent. The objective of current research was to assess medical and radiographic results of Vital Pulp Therapy utilizing iRoot BP Plus in eternal teeth affected by irreversible pulpitis produced through dental caries. Furthermore, study aimed to analyze the preoperative factors that impact the prognosis of VPT [16].

Image 2:



METHODOLOGY:

Research Objective: Clearly define aim of our current research, which is to explore the effectiveness of vital pulp treatment in treatment of mature permanent teeth having irreversible pulpitis.

Study Design: Determine the appropriate study design to address the research objective. A randomized controlled trial is typically gold standard design for evaluating treatment effectiveness. Alternatively, a prospective cohort study or a case-control study can also be considered.

Sample Selection: Define the inclusion and exclusion criteria for selecting participants. In this case, select patients with mature permanent teeth diagnosed with irreversible pulpitis. Consider aspects just like age, gender, medical record, and tooth-specific criteria to ensure the sample represents the target population accurately.

Ethical Considerations: Obtain ethical approval from related research ethics boards or institutional appraisal boards. Ensure that participants provide informed consent to participate in the study and that their privacy and confidentiality are protected.

Randomization and Allocation: If conducting an RCT, randomize the participants into different treatment groups to minimize bias. Use appropriate methods such as computer-generated randomization or block randomization. Randomly assign individuals to either the group receiving vital pulp therapy or the control group.

Intervention: Clearly describe the vital pulp therapy technique being evaluated. Provide details on materials used, protocol, and any standardized guidelines followed. It is essential to have skilled and knowledgeable clinicians administer the treatment.

Control Group: If using a control group, outline the standard treatment protocol being followed (e.g., root canal treatment) and any specific variations from the standard procedure, if applicable. Clearly define the criteria for selecting the control group.

Outcome Measures: Determine the primary and secondary outcome measures to evaluate the effectiveness of vital pulp therapy. Primary outcome measures may include pain relief, preservation of tooth

vitality, success rate, and nonappearance of clinical signs and symptoms. Secondary measures may include radiographic findings, patient satisfaction, and quality of life assessment.

Data Collection: Develop a data collection plan and establish a standardized data collection form. Train researchers or clinicians involved in data collection to ensure consistency and reliability. Collect relevant data, including demographic information, clinical examination findings, treatment procedures, and follow-up data.

Statistical Analysis: Analyze the collected data using appropriate statistical methods. Compare the results between the vital pulp therapy group and the control group using appropriate statistical tests, such as chi-square tests, t-tests, or survival analysis. Set the significance level and adjust for confounding factors if necessary. Remember, this is a general methodology outline, and the specifics may vary depending on the context, resources, and requirements of your study.

The patients underwent a clinical and radiographic assessment at 4, 8, and 14 months, followed by annual check-ups. The case's success hinged on the following factors: (1) the lack of prior complaints regarding spontaneous discomfort or pain; (2) the absence of tenderness when pressure, touch, or exposure to hot and cold stimuli were applied to the tooth; (3) minimal or no detectable movement (grade I mobility); (4) the presence of healthy surrounding soft tissues without swelling or sinus tract; (5) intact filling materials functioning normally; (6) no signs of periapical tissue disease or external resorption visible in the X-rays; (7) no signs of intraarticular disease or internal resorption visible in the X-rays; (8) ongoing radiographic evidence of root development in immature roots.

RESULTS:

Seventy patients, suffering from irreversible pulpitis due to dental caries, had a total of sixty-five permanent teeth treated using iRoot BP Plus. For evaluation, a group of sixty-five participants (containing of 29 males and 36 females, aged among 5 and 19 years) with a follow-up rate of 95.5% were accessible. The average age of patients who underwent VPT was 12.74 ± 4.82 years. The back-up inspection phase diverse from 7 to 39 months, having an mean duration of 17.1 ± 5.57 months. Throughout follow-up period, success rate of VPT was 92.3% (54 out of 65 cases). DPC

exhibited a success rate of 96.5% (25 out of 27 cases), PP showed a success rate of 91.7% (20 out of 27 cases), and FP demonstrated a success rate of 86.5%

(12 out of 16 cases). Figure 2 displays radiographs of distinctive cases of DPC, PP, and FP.

Table 1: Matching of the regression model results.

Influencing	S.E.	Sig.	Factors B	Exp (B)	Wald
Age	2.918	1.957	4.085	0.018	0.163
Sex (1)	3.187	0.289	1.173	4.229	0.593
Referred pain (1)	3.516	0.126	0.892	0.412	0.724
Spontaneous pain (1)	1.957	0.001	4.957	0.001	0.998
Nocturnal pain (1)	1.838	1.516	3.261	0.105	0.219
Heat test	0.658	0.387	0.413	1.508	0.534
Pain level of cold test	2.254	0.805	2.021	3.541	0.372
test difference	1.887	0.001	3.206	1.123	0.997

The construction of a binary logistic regression model involved utilizing SPSS 25.0 software. Following that, a logistic regression investigation was achieved to investigate prognosis and their associated aspects. The dependent variable was defined as the prognosis, while several factors from Table 1 were chosen as independent variables. A binary logistic regression model was developed utilizing these selected variables. Previously fitting model, the regression coefficient variance decomposition method was employed to evaluate multicollinearity among 15 variables. The findings revealed that entirely index variance inflation factors were less than six, except for a single condition index that surpassed 16. Additionally, variance ratio of altogether variables within the current dimension was below 0.9, signifying the absence of collinearity among the independent variables. Hence, these variables could be employed as independent variables in binary logistic regression analysis.

The findings of binary logistic regression model, presented in Table 2, showcase the results pertaining to the prognosis prediction of pulpitis. Within the model, 14 independent variables were considered, encompassing gender, age, root maturation, cave shape, spontaneous pain, nocturnal pain, referred pain, cold test, pain level during cold test, hot test, pain level during hot test, variance in electrical vitality test, percussion sensitivity, and VPT type. These variables completed essential requirements for accurately modeling the prognosis. The Hosmo test result for this model indicates a significance level greater than 0.06, suggesting a satisfactory fit. The analysis in Table 2 reveals that consequence values of 16 independent variables exceed 0.06. Therefore, based on the p-value of 0.05, there is currently no conclusive evidence to demonstrate a significant influence of the aforementioned factors on patients' prognosis.

Table 2: In irreversible pulpitis, factor allocation of a binary logistic regression model:

Variable Name	Variable Description	Assignment
Gender	Male	2
	Female	1
Root maturation	Closed	1
	Open	0
Spontaneous pain	Yes	1
	No	0
Referred pain	Yes	1
	No	0
Pain level of cold Test	>5	1
	<5	0

DISCUSSION:

Vital pulp treatment refers to treatment of dental pulp, which is inmost layer of tooth containing nerves and blood vessels [17]. When the pulp becomes inflamed or infected, it can lead to irreversible pulpitis, a condition in which the pulp cannot recover and requires intervention [18]. While vital pulp therapy is usually utilized in immature teeth, its application in mature permanent teeth having irreversible pulpitis has been a subject of debate among dental professionals. Traditionally, root canal therapy has been very favored technique of handling irreversible pulpitis in mature permanent teeth [19]. It involves removing entire dental pulp and filling the root canals with an inert material. However, this procedure weakens the tooth structure and may necessitate the placement of a crown, which can be expensive and time-consuming. In current years, here was huge increasing notice in preserving strength of pulp in mature permanent teeth with irreversible pulpitis [20]. This approach involves removing the inflamed or infected portion of the pulp while maintaining the healthy pulp tissue. Various techniques, such as partial pulpotomy and direct pulp capping, was projected for vital pulp therapy in those cases [21]. Advocates of vital pulp therapy argue that it allows for the preservation of natural tooth structure and function, reducing the need for extensive restorative procedures. It also maintains the tooth's potential for continued root development and responsiveness to external stimuli [22]. Additionally, vital pulp therapy has shown promising outcomes in terms of long-term success rates and patient satisfaction. However, critics express concerns regarding the predictability and long-standing results of vital pulp treatment in mature permanent teeth. They argue that infected pulp tissue may not be entirely removed, leading to persistent or recurrent infections [23]

Furthermore, the pulp tissue in mature teeth is fewer resilient and may have a reduced capacity for healing compared to immature teeth. In conclusion, vital pulp treatment of mature permanent teeth having irreversible pulpitis is a topic of ongoing discussion and research in the field of dentistry [24]. While it offers the advantages of preserving tooth structure and function, further studies are needed to establish its efficacy and long-term success rates [25]. Dentists must carefully evaluate individual cases, considering factors such as the extent of pulp inflammation, patient age, and overall tooth condition, to make informed

decisions regarding the most appropriate treatment approach [26].

CONCLUSION:

Vital pulp therapy using iRoot BP Plus, which includes direct pulp capping, partial pulpotomy, and full pulpotomy, proved to be an effective treatment for irreversible pulpitis resulting from caries in patients aged 5 to 19 with permanent teeth.

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