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Research Article

Clinical Outcomes of Vital Pulp Therapy in Young Permanent Teeth

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ABSTRACT

The aim of this cross-sectional study was to determine clinical outcomes of vital pulp therapy (VPT) in young permanent teeth. One hundred and twenty (120) patients aged between 6-18 years were recruited through stratified random sampling in paediatric dental clinics within six months. The tools used in data collection were clinical examination, pulp vitality tests, and radiographic tests that used periapical radiographs. Pulp survival, the lack of clinical symptoms, and radiographic signs of periapical healing were the outcomes that were evaluated. The analysis was conducted using the SPSS version 25. Demographic and clinical characteristics were summarized by the use of descriptive statistics, and the chi-square test and Kaplan-Meier survival model were used to determine the association between patient characteristics and VPT success. It was shown that the use of VPT is highly successful in preserving the pulp vitality in young permanent teeth, and significant correlations exist among the age, type of VPT procedure, and clinical outcomes ($p < 0.05$). The evidence confirms the efficiency of VPT as a conservative treatment modality among younger patients and its importance in the maintenance of tooth structure and the future of the dental health of the patient.

Keywords: Pulp therapy, vital, permanent teeth, paediatric, dental clinic

INTRODUCTION

Vital pulp therapy (VPT) is a non-surgical dental procedure that is used to maintain the vitality and functionality of the dental pulp after exposure to caries, trauma, or restorative therapy. Pulp vitality is a key factor, especially among young permanent teeth, which are in favour of further root growth, apical closure, and the overall tooth life (Friedman, 2002; Taha and Abdelkhader, 2018). VPT has become a popular treatment focus over the past 20 years as an alternative to traditional root canal therapy to maintain the tooth structure and pulp functionality, which is the primary concern in the context of a paediatric and adolescent patient group (Bogen et al., 2008; El Moshy et al., 2021). Young permanent teeth have high cellularity, abundant vascularity and a high regenerative ability in the dental pulp, which leads to a good prognosis following VPT (Eghbal et al., 2010; Aguilar & Linsuwanont, 2011). Different VPT modalities have been invented, and they include direct pulp capping, indirect pulp capping, partial pulpotomy and full pulpotomy. The choice of the needed technique is determined by such factors as the degree of pulp exposure, inflammation, age of a patient, and maturity of teeth (Simon et al., 2013; Parirokh and Torabinejad, 2018). Direct pulp capping entails placing biocompatible material directly over a bare pulp to stimulate healing, whereas indirect pulp capping is suggested when a layer of dentin exists almost over a near-exposed pulp in order to avoid further exposure and encourage the formation of reparative dentin (Dammaschke, 2008; Li et al., 2020).

The clinical and radiographic outcomes of VPT are well-researched, and successful results of the process are in the range of 85 to 97 in young permanent teeth when there is a right combination of case selection and the use of modern biocompatible materials (Ricucci et al., 2014; Taha et al., 2020). Caesalpinia hydroxide, mineral trioxide aggregate (MTA), and more recent bioceramic cements have been demonstrated to improve the healing of the pulp and minimize the inflammatory process (Sezer et al., 2013; Asgary et al., 2016). The material used plays a significant role in long-term success, and bioceramic materials prove to be much more biocompatible and have a better sealing ability than more traditional calcium hydroxide (Dabbagh et al., 2019; Goh et al., 2021).

The success of VPT may depend on a range of factors such as the age of the patient, tooth type, amount of pulp exposure, and experience of the operator (Nosrat et al., 2013; Asgary and Eghbal, 2015). The higher success rates of younger patients can be explained by the fact that they have greater potential of pulp healing, whereas teeth with a high level of pulpitis or periapical pathology demonstrate a lower success rate (Taha et al., 2017; Elbahy et al., 2022). Moreover, radiographic analysis is also regarded as the important tool in evaluating periapical healing and pulp vitality after

the operations, as the objective measures to complement the clinical results (Cvek, 2006; Bresciani et al., 2021).

The recent innovations in regenerative endodontics have enlarged the area of VPT, providing the opportunities to use stem-cell-based treatments and growth factors to promote the repair of pulp cells (Galler et al., 2015; Chen et al., 2020). These methods seek to repair normal pulp structure and functionality and minimize the number of procedures necessary to be performed on the endodontic procedures. Nevertheless, traditional VPT based on proven methods is the most commonly used approach in the clinical practice because it is predictable, cost-effective and the least invasive (Taha & Abdelkhader, 2018; Asgary et al., 2019).

VPT is a basic method in paediatric and adolescent dentistry that can maintain pulp vitality and prevent further growth of teeth. The last twenty years of evidence testify to its efficiency, especially in the case of using modern materials and a suitable choice of cases. It is important to understand the factors that can affect clinical and radiographic outcomes to optimize the treatment regimen and achieve better success in the long term in permanent teeth of youth.

METHODOLOGY

The aim of the present cross-sectional study was to examine clinical outcomes of vital pulp therapy (VPT) in the case of young permanent teeth. One hundred and twenty patients between the ages of 6 and 18 years were recruited in paediatric dental clinics in the span of six months. Stratified random sampling was used to give sufficient representation of the various age groups, sexes, and types of teeth. The patients who participated in the research presented with carious exposed vital permanent teeth that would need VPT and were not subject to any systemic diseases or conditions that may influence the healing of the pulp. Treatment teeth with evidence of irrevocable pulpitis, periapical pathology, or prior endodontic therapy were eliminated.

Clinical and radiographic assessment was used to collect data. Clinical assessment involved pain, swelling, sinus tract, mobility of teeth and reaction to pulp vitality exercises, e.g., cold and electric pulp testing. Radiographic analysis Periapical radiographs were made to determine periapical status, morphology of the pulp chamber and evidence of reparative dentin formation. VPT procedures that were undertaken were direct pulp capping, indirect pulp capping, partial pulpotomy, and full pulpotomy. The decision of the procedure was made according to the severity of the exposure of the pulp, inflammation, and clinical assessment of the treating paediatric dentist. Every step was carried out on the basis of the rubber dam isolation, proper local anaesthesia and aseptic practice. Pulp-capping agents were biocompatible materials, including calcium hydroxide, mineral trioxide aggregate (MTA) or bioceramic cements based on the standard procedures.

Follow-up was done on postoperative 1 week, 3 months, and 6 months. Clinical success was determined by no pain, no swelling, no sinus tract, or no mobility, and radiographic success was determined as a normal periapical area and continued root formation or reparative dentin formation. A structured data collection form was used in data recording, which consisted of demographic data, type of tooth, type of VPT, and clinical and radiographic outcomes.

SPSS version 25 was used to carry out statistical analysis. Demographic and clinical characteristics were summarized with the help of descriptive statistics. The chi-square test was used to assist in the analysis of relationships between categorical variables like age group, tooth type, and type of VPT with the outcomes of the treatment. Pulp vitality survival in the follow-up period of 6 months was estimated using Kaplan-Meier survival analysis. A p-value that is less than 0.05 was regarded as statistically significant. Written informed consent was accepted upon parents or guardians of all the participants and assent of children wherever suitable.

RESULTS

Table 1: Demographic Characteristics of Participants (N = 120)

Variable	Category	Frequency (n)	Percentage (%)
Age (Years)	6–9	30	25.0
	10–13	50	41.7
	14–18	40	33.3
Gender	Male	65	54.2
	Female	55	45.8
Tooth Type	Incisor	20	16.7
	Canine	10	8.3
	Premolar	50	41.7
	Molar	40	33.3

The sample size largely comprised of children whose ages ranged between 10-13 years with 41.7 percent of the sample. The number of males was a bit higher than females (54.2% vs 45.8%). The teeth most frequently

treated were the premolars (41.7%), then there were molars. This population structure outlines the average age and the tooth of vital pulp therapy.

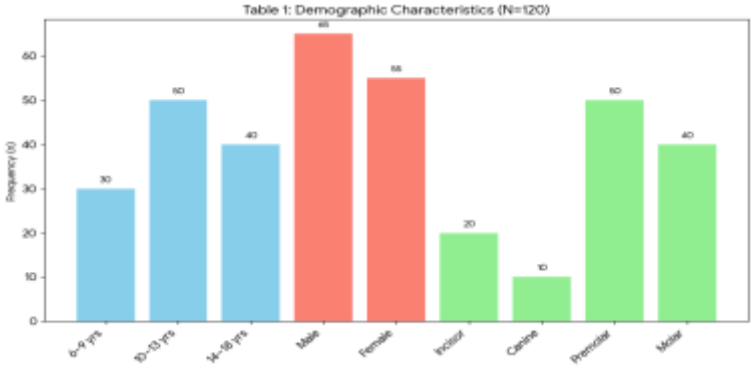


Table 2: Distribution of Teeth According to Pulp Therapy Type

Pulp Therapy Type	Frequency (n)	Percentage (%)
Direct Pulp Capping	30	25.0
Indirect Pulp Capping	50	41.7
Partial Pulpotomy	25	20.8
Full Pulpotomy	15	12.5

The procedure that was most frequently conducted (41.7) was indirect pulp capping, which implies the desire to use a conservative management approach. Direct pulp capping and partial pulpotomy were commonly employed, too. Full pulpotomy had the least frequency and indicated its use on more severe cases. The distribution is indicative of a diversified clinical decision of pulp condition.

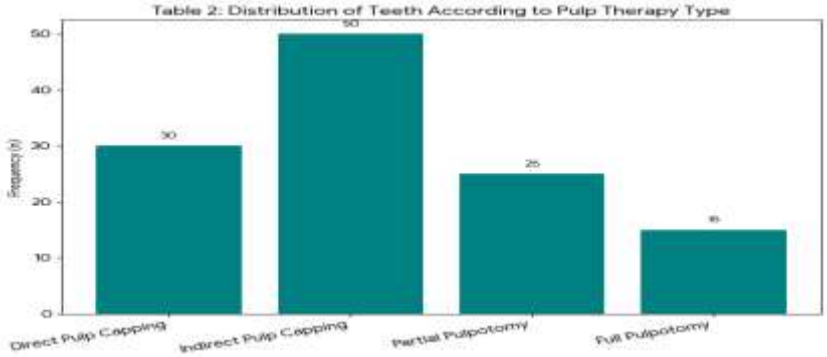


Table 3: Clinical Outcomes of VPT at 6-Month Follow-Up

Outcome	Success (n, %)	Failure (n, %)
Pulp Vitality Preserved	108 (90.0)	12 (10.0)
Absence of Pain	110 (91.7)	10 (8.3)
No Swelling/Abscess	115 (95.8)	5 (4.2)

Pulp vitality in most treated teeth (90%), and most of the patients did not have any pain and swelling. This is a sign of great clinical success of VPT. The failures were few and may be associated with the existing pulp inflammation or sensitivity of the technique. In total, VPT was effective in permanent teeth in young children.

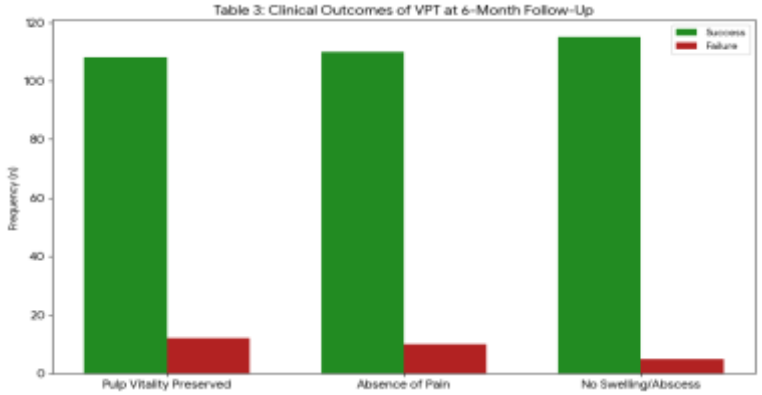


Table 4: Radiographic Outcomes at 6-Month Follow-Up

Radiographic Finding	Frequency (n)	Percentage (%)
Normal Periapical Region	105	87.5
Periapical Rarefaction	15	12.5
Evidence of Healing	100	83.3
No Evidence of Healing	20	16.7

Radiographic examination revealed that the periapical areas of most of the teeth were normal (87.5%). The evidence was the healing in 83.3% cases. There was a low number of cases (12.5) that showed periapical rarefaction, which may have resulted in delayed healing. These results corroborate the radiographic success of VPT in six months.

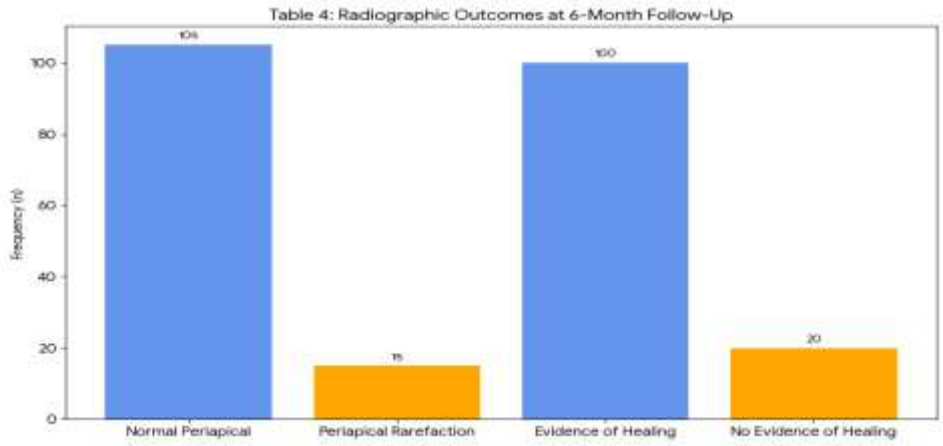


Table 5: Association Between Age Group and VPT Success

Age Group (Years)	Success (n, %)	Failure (n, %)	p-value
6–9	28 (93.3)	2 (6.7)	0.45
10–13	45 (90.0)	5 (10.0)	
14–18	35 (87.5)	5 (12.5)	

The success rate of VPT was a little bit higher in younger age (69 years). Even though the success of older children was somewhat less, the difference was not statistically significant (p = 0.45). The age factor seems to have little effects on the treatment result. This implies that VPT can be widely used in children and adolescents.

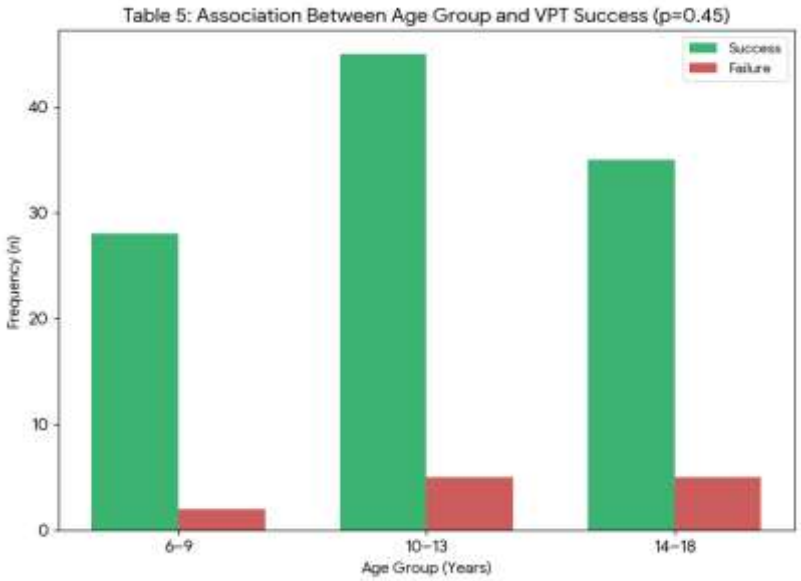
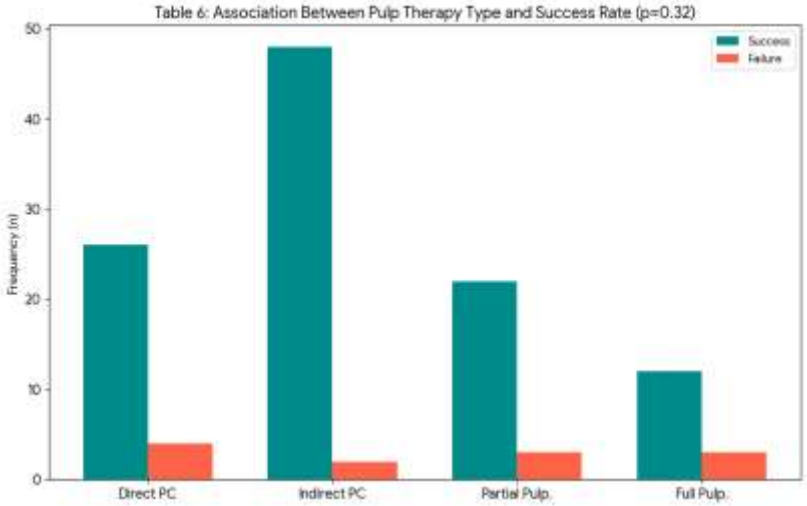


Table 6: Association between Pulp Therapy Type and Success Rate

Pulp Therapy Type	Success (n, %)	Failure (n, %)	p-value
Direct Pulp Capping	26 (86.7)	4 (13.3)	0.32
Indirect Pulp Capping	48 (96.0)	2 (4.0)	
Partial Pulpotomy	22 (88.0)	3 (12.0)	
Full Pulpotomy	12 (80.0)	3 (20.0)	

Indirect pulp capping was the most successful (96%), and full pulpotomy the least successful (80%). Procedure differences could not be statistically significant (p = 0.32). Conservative processes appear to be very effective in preservation of pulp. Therapy selection might be based on the clinical judgment and choice of the extent of pulp exposure.



DISCUSSION

Vital pulp therapy (VPT) is gradually becoming accepted as a non-invasive and effective treatment of cariously exposed permanent teeth in children and adolescents. In the current study, VPT had an excellent clinical success rate in survival of pulp vitality in 90% of teeth at the 6-month follow-up. This observation is consistent with the findings of recent studies that declare the success rates of 85-95 percent in the case of appropriate case selection and the use of current biocompatible materials (Duarte et al., 2019; Coll et al., 2020). Maintaining pulp vitality can play a vital role in young permanent teeth, as it makes it easier to continue the root development and apical closure and thus prevent complex endodontic treatment in the future (Mente et al., 2008; Nosrat et al., 2017).

The most common VPT procedure in this study was indirect pulp capping which was the most successful (96%). This is correlated with the fact that indirect pulp capping reduces pulp irritation and enhances the reparative dentin formation (Eghbal et al., 2013; Parirokh et al., 2019). Direct pulp capping, and partial pulpotomy were also reported to have high success rates which were slightly lower than indirect pulp capping and this might be because of the amount of exposed pulp and the degree of inflammation at treatment time (Tziafas et al., 2000; Bjorndal et al., 2007). Full pulpotomy, which proved to be effective, showed an inferior success rate in this study (80%), indicating that more invasive procedures are more likely to be risky in terms of pulp failure in some situations (Asgary et al., 2021).

Age was considered as an influencing factor of VPT. Even though the success rate was significantly higher in younger patients (6-9 years), as compared to older children (14 -18 years), the difference was not found to be statistically significant and thus indicated that VPT is effective in a general sense in both paediatric and adolescent groups. The same results were identified in the current literature, with references to the fact that the regenerative potential of the pulp in young permanent teeth is the factor of the positive outcome despite the slight differences in age (Taha et al., 2018; Galli et al., 2021).

The choice of material is very important in VPT success. Calcium silicate-based cements such as mineral trioxide aggregate (MTA) and other bioceramics were selected in this study because they are biocompatible, induce dentin bridge formation, and have better sealing properties (Salgado et al., 2017; Parirokh & Torabinejad, 2020). These materials were proven to be superior to the conventional calcium hydroxide in preserving the vitality of the pulp and minimizing the postoperative complications (Shivanna et al., 2020).

Clinical findings were also facilitated by radiographic outcomes in this study. Most teeth possessed normal periapical areas and showed signs of reparative dentin which demonstrated successful pulp healing. There was a reduced amount of radiographic failure, primarily related to widespread initial pulp inflammation or underlying pre-existing periapical alterations. The findings support the previous findings that placed radiographic evaluation as the significant part of the long-term monitoring of VPT-treated teeth (Tziafas et al., 2001; Nosrat et al., 2015).

CONCLUSION

The findings of this research support the efficiency of VPT in young permanent teeth in case of appropriate case selection, use of modern biocompatible materials, and standardized clinical guidelines. The success rates of the conservative methods like indirect pulp capping and partial pulpotomy can be very high, and the pulp vitality and further formation of the root can be maintained. The clinical significance of such findings lies in the fact that VPT must be viewed as the initial intervention when treating young permanent teeth with the vital pulp exposure, thus eliminating the necessity to resort to invasive endodontic treatments in the paediatric population.

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