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Case Report: Vital Pulp Therapy In Immature Permanent Teeth Diagnosed With Symptomatic Irreversible Pulpitis With Calcium Silicate Based Material

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Abstract:
Root canal treatment (RCT) has been considered the conventional standard for the management of teeth with carious pulp exposure, particularly in mature teeth presenting with symptoms. Following a better understanding of the histopathology of deep carious lesions, the histology of the cariously exposed pulp and the healing potential of the inflamed pulp, vital pulp therapy (VPT) is increasingly adopted around the world for the management of permanent teeth with clinical signs and symptoms indicative of irreversible pulpitis. The aim of this study was to describe the treatment of permanent teeth with open apex diagnosed with irreversible pulpitis, which can be effectively managed with partial or total pulpotomy. In this clinical case, tooth exhibited symptoms of intense pain upon exposure to cold and hot intake. The clinical examination revealed extensive caries, while radiographic imaging showed radiolucent lesions in contact with the pulp chamber, indicating symptomatic irreversible pulpitis. The chosen treatment approach was either partial or total pulpotomy. The tooth was anesthetized, and the operative field was isolated and disinfected. After removing caries with a sterile round drill, the area was rinsed with sodium hypochlorite. In this case, a portion of the pulp tissue was removed using diamond burs. Hemostasis was achieved by applying sterile cotton pellets for 2 to 6 minutes. Following that, the tissue exhibited no signs of bleeding. Calcium silicate-based cements was used, and the tooth was restored. Periodic follow-up examinations were conducted.

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I. Introduction

One of the causes of pulp inflammation and infection is dental caries, which initiates an inflammatory response process and eventually leads to pulp necrosis; the dental pulp serves important functions such as formation, nutrition, protection, and repair. When it becomes infected by bacteria, it manifests signs and symptoms of reversible pulpitis. Without treatment, the disease progresses to an irreversible state, leading to consequences such as infections, tooth loss, pain, and a decline in self-confidence [1]. Currently, the standard treatment for irreversible pulpitis is root canal treatment; this procedure involves the complete removal of inflamed and infected pulp tissue to prevent the development of apical periodontitis and to preserve the tooth within the oral cavity [2]

Nowadays, advancements in materials and research in histology and microbiology have led to improved conservative protocols for dental pulp treatment [3]. Consequently, endodontic societies are proposing new guidelines for managing situations involving deep caries, extremely deep caries, and irreversible pulpitis [4]. However, accurate diagnosis of the pulp condition is crucial in determining the appropriate therapy [5].

Vital pulp therapy offers great benefits over conventional root canal treatment (RCT). In cases with immature apices, preserving the vitality of the tooth is beneficial for the continuation of root development, enhancing the strength of the affected tooth [6]. Another advantage offered by VPT over conventional RCT is better protective resistance against masticatory forces [7].

Vital pulp therapy (VPT) has been defined as treatment which aims at preserving and maintaining the pulp tissue that has been compromised but not destroyed by extensive dental caries, dental trauma, and restorative procedures or for iatrogenic reasons [8]. Zhang and Yelick used another definition which added, "Stimulating the remaining pulp tissue to regenerate the dental pulp complex" to the previous definition [9] Vital pulp therapy involves various approaches, including indirect and direct pulp capping, as well as partial or total pulpotomy. The primary goal is to maintain pulp vitality and provide the most effective and conservative treatment that is also affordable for the patient .The European Society of Endodontology quality guidelines for endodontic treatment 2006, states that indirect pulp capping is a procedure in which a protective cement or dressing placed over a thin layer of remaining sound or slightly softened dentine which if removed, it might expose the pulp. Direct pulp capping defined as: at the site of pulpal exposure, the pulp is covered with a protective dressing or base, which aims at protecting the pulp from additional injuries and permits healing and repair [10]

Partial and total pulpotomies are not new treatments. Initially, it was recommended for treating permanent teeth with immature apices, where complete root formation is necessary. However, new clinical trial studies provide evidence that it can be an alternative treatment for cases involving mature permanent teeth with a fully formed apex and irreversible pulpitis .[11, 12]

A correct protocol for isolation, asepsis, and clinical evaluation during the intraoperative procedure for bleeding and hemostasis allows for greater success in treatment [13]. Another important factor to consider is the choice of capping material. Historically, calcium hydroxide was the most commonly used material in vital pulp therapy. However, recent clinical studies have shown that MTA and calcium silicate-based cements yield better results when treating deep carious lesions with exposed pulps, leading to favorable outcomes. Additionally, calcium silicate materials possess properties of cellular biocompatibility and bactericidal effects.[14, **15**, 16.]

Follow-up studies have shown that vital pulp therapy (VPT) has a high success rate when combined with proper restoration, effectively preventing bacterial infiltration and contamination in the oral cavity . It is considered a less invasive, cost-effective, and pulp-preserving alternative.

II. Case Description And Results

This case report has been written according to the Preferred Reporting Items for Case Reports in Endodontics (PRICE) 2020 guideline.

15 year old male patient reported to the Department of Conservative dentistry and Endodontics of our College with the complain of food logdement and intense pain in lower left molar of jaw since 15 days.

History of present illness revealed that Patient was apparently alright before three months then he noticed caries in left second molar of mandibular jaw and 15 days before he started having pain in left second molar of mandibular jaw which was aggrevated on hot and cold intake as well as during mastication which was spontaneous for few seconds and releaved after the removal of cause. Patient had no history of pain on night and swelling.

On clinical examination, it was seen that patient had extensive carious tooth with left mandibular second molar. Tooth showed negative results on percussion test. Hot and cold test were positive

Additionally, the radiographic examination revealed radiolucent images in direct contact with the pulp chamber in left mandibular second molar with immature apex.(Fig. 1).

The diagnosis for tooth was symptomatic irreversible pulpitis with normal periapical tissues. The chosen treatment for tooth was either partial or total pulpotomy. Before signing the informed consent form, the patients were informed about the benefits and disadvantages of the treatment compared to other options.

The anesthetized using Lignocaine 2% with adrenaline (1:100000) anesthetics under absolute isolation and disinfection of the operative field. Nonselective removal of caries was performed in the following manner: the caries were excavated using a large sterile round diamond drill, starting from the outermost area and progressing towards the inner part. This procedure was carried out at a slow speed with water coolant once all the carious lesion was removed, a sterile spoon excavator was used to make contact with the pulp tissue. This procedure was carried out with saline as coolant and irrigating solution. The presence of pulp hemorrhage upon entering the pulp chamber confirmed the clinical diagnosis of a vital pulp. The exposed pulp was carefully removed using a sterile spoon excavator, while being cooled with saline coolant with the help of syringe.

In the evaluation, it was considered that all the whitish and avascular tissue had been completely removed. The inflamed tissue was deemed irreversibly damaged due to the abundant bleeding it exhibited. The pulp tissue that was not removed had a bleeding time for less 10 minutes and show no morphological changes. If the bleeding would not have stopped, root canal treatment would have been planned. But in our case, both teeth had an adequate hemostasis time.

The tissue was excised to a depth of 3-5 mm from the entire coronal pulp, representing a partial pulpotomy. Hemostasis was achieved in the tooth following the pulpotomy procedure by placing sterile cotton pellets in the pulp wound for a duration of 10 minutes. The cavity was rinsed with the saline solution

Next, Mineral Trioxide Aggregate was used as pulp capping material according to the manufacturer's instructions. After pulp capping, the tooth was restored with using Glass Ionomer cement.

The immediate post-treatment evaluation showed that patient did not have postoperative pain. Periodic follow-up examinations were conducted, evaluating pulp vitality, palpation, and percussion pain. The tooth was asymptomatic and responded normally to the thermal test. There was no pain upon percussion and radiographically, did not showed evidence of periapical radiolucent lesions. Additionally, no obliterations of the root canal were observed. In the unlikely event that they had occurred, an urgent canal treatment (pulpectomy) would have been planned. After 6 months follow up, immature apices exhibited complete formation of the root apices.

Fig. 1 Preoperativr Radiograph With 37

Fig. 2 After Caries Excavation With 37

Fig. 3. MTA Placement And Restoration Using GIC With 37

Fig. 4: 1 Month Follow Up With 37 Showing Apex Formation

Fig. 5: Follow Up After 6 Months

Fig. 6Follow Up After 1 Year

III. Discussion

The successful management of pulp inflammation and infection hinges on the elimination of the underlying cause—whether it's a substance released or direct contact with pulp tissue—that triggers the inflammatory response . Bacterial interaction with pulp tissue can provoke pain, particularly in response to thermal stimuli, osmotic agents, and, in some cases, spontaneous discomfort[17].

Historically, Root Canal Therapy was the standard treatment for such conditions. However, advances in microbiology, histology, and the development of improved pulp capping materials have shifted the focus toward more conservative approaches aimed at preserving pulp vitality. Partial and total pulpotomies have now become the preferred treatment modalities. Numerous recent studies support these conservative approaches, showing high success rates both clinically and radiographically[18].

The implementation of aseptic isolation, the use of magnification, and the application of Calcium Silicate based cements such as MTA . have significantly contributed to improved treatment outcomes. Compared to calcium hydroxide , which was widely used for decades, bioceramic materials have demonstrated superior success rates when used as pulp capping agents[19].

The clinical case presented in this study illustrate that vital pulp therapy, particularly pulpotomy, is a viable treatment option for permanent teeth with open apex diagnosed with symptomatic irreversible pulpitis. Accurate diagnosis and adherence to established clinical protocols—such as those outlined by other researchers —have resulted in favorable outcomes using a variety of bioceramic cements [21,22].

MTA has been suggested as the material of choice in cases of pulp capping, pulpotomies, perforative root resorption defects, surgical root end filling (retrograde filling), root and pulp chamber perforations and in cases undergoing revascularization treatment[23]. MTA was first introduced into literature in the 1990s as an experimental calcium silicate based material[24]. MTA is a broadly used material used to seal pulpal cavities and external root surface communications[25]. MTA is composed of Portland cement, which is mainly composed of tri-calcium and di-calcium silicate, and bismuth oxide as radiopacifier[26].

MTA has been reported to be a biocompatible material, which has inductive and conductive abilities for hard tissue formation[27]. It is bactericidal, stimulates cementum-like hard tissue formation and bone regeneration[28].

Regarding MTA as a pulp capping material, it was concluded by Nair et al., after a randomized control study that MTA was clinically easier to use, resulted in less pulpal inflammation and had more predictable outcomes regarding hard tissue barrier formation when compared to calcium hydroxide[29]. In a meta-analysis study, investigators reviewed 13 studies that had been conducted since 2003. 5 of the studies, involving 931 teeth, reported success rates between MTA and CH. While the other nine investigated the inflammatory response and dentine bridge formation differences between calcium Hydroxide and MTA. It was concluded from this meta-analysis that MTA had significantly superior success rates to CH. MTA specimens showed less pulpal inflammation in comparison to the CH specimens and that a higher percentage of calcified dentine bridge formation was noticed in the MTA capped groups[30].

Hemostasis was achieved within 10 minutes. Lin et al. reported that the optimal time to achieve hemostasis ranges from 8 to 15 minutes, and if bleeding persists beyond this, a pulpectomy should be considered . Similarly, Ricucci et al. recommended modifying the treatment approach if bleeding is not controlled in a reasonable time—potentially shifting from partial to full pulpotomy, or from pulpotomy to pulpectomy—suggesting a 2-minute window for decision-making [31]. Conversely, Santos et al., in a recent in vivo histological study on an animal model, found that the duration of hemostasis does not significantly impact pulpotomy success in permanent teeth. These varying findings highlight the need for further research to establish a consensus.

Disinfection of the exposed pulp during the pulpotomy procedure is as critical as the choice of capping material. In the current study teeth were irrigated with saline solution showed successful outcomes, aligning with findings by Brizuela et al., who reported positive results with saline[32]. Teeth were restored with glass ionomer cement with 47, definitive restorationwas done using composite resin. Previous research has demonstrated that glass ionomer can effectively prevent bacterial leakage for up to one month, supporting its use as a temporary restorative material[33].

The follow-up of the case presented in this study was a minimum 1 year. Currently, most studies have a follow-up period of 1 or 2 years, and there are few studies with a longer follow-up period that demonstrate a high percentage of success . In the radiographic evaluation, the formation of the dentin barrier (Figures **6** and **7**), presence of pulp vitality, and absence of periapical lesions were observed. The closure of the apices was also observed.

IV. Conclusion

Vital pulp therapy (VPT), particularly partial pulpotomy, is a viable and effective alternative to root canal treatment for managing symptomatic irreversible pulpitis in teeth with immature apices. With accurate diagnosis, strict asepsis, and the use of biocompatible materials like MTA, pulp vitality can be preserved, promoting continued root development. This conservative approach reduces treatment complexity and cost while maintaining tooth structure. The presented case showed favorable clinical and radiographic outcomes. These findings support the growing shift toward minimally invasive, pulp-preserving therapies in endodontic practice.

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