

Article

Treatment of Devital Permanent Anterior Teeth with Incomplete Root Development

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Abstract: When treating post-traumatic teeth in children, special attention should be paid to the use of regenerative endodontic techniques, especially in cases where root development is incomplete and even the use of mineral trioxide aggregate does not contribute to the improvement of the tooth condition.

Keywords: Tooth Trauma, Incomplete Root Development, Regenerative Endodontic Technique

Introduction

Trauma to teeth is common in young children and is one of the most frequent causes of loss of pulp vitality in permanent incisors with incomplete root development. Dental health surveys have shown that 11% of 12-year-olds and 13% of 15-year-olds have suffered accidental injuries to permanent teeth, with the majority of these cases remaining untreated. Most dental treatments were performed in patients aged 15, of whom only 27% received treatment for damaged incisors [1].

The restoration of devital teeth with incomplete root development presents an extremely complex challenge due to the disrupted crown-to-root ratio, thin dentinal walls, and wide-open apex without an apical stop to condense the filling material. Therefore, treatment of such teeth is time-consuming and technically demanding. Traditionally, treatment has aimed to create an apical barrier against which root canal filling material can be condensed, preventing its extrusion into periapical tissues. This is typically achieved through apexification using calcium hydroxide (Ca(OH)₂). Although this method has proven reliable and produced stable clinical outcomes, recent concerns have been raised regarding the long-term use of Ca(OH)₂ in root canals. This may be due to its hygroscopic and proteolytic properties, which cause dehydration of dentinal proteins and reduce root strength, predisposing the tooth to root fractures [2].

In recent years, there has been a shift toward modifying treatment approaches for teeth with incomplete root development that have become devitalized due to trauma, caries, or developmental

anomalies. This change was prompted by the limitations of $\text{Ca}(\text{OH})_2$ and mineral trioxide aggregate (MTA) techniques. Both methods allow canal obturation by creating a physical barrier, but neither promotes structural improvement or regeneration of the root. Moreover, both may have a detrimental effect on dentin and increase the risk of root fracture, especially with prolonged use of $\text{Ca}(\text{OH})_2$.

To achieve continued dentin or cementum deposition and thus qualitative root development, a tissue capable of cellular activity and proliferation must be established. Recently, attempts have been made to restore the blood supply of devitalized teeth using regenerative endodontic techniques (RET). This approach is based on the use of stem cells, complete disinfection of root canals, placement of a scaffold within the canal, and signaling to stem cells to induce differentiation [3].

There are several potential sources of stem cells in the oral cavity, and some researchers suggest that stem cells of the apical papilla (SCAP) play a crucial role in regenerative procedures [4]. It has recently been shown that stem cells are present in the apical region of incompletely developed roots in children and adolescents. W. Sonoyama et al. demonstrated that isolated SCAP cultured in vitro possess the ability to undergo dentinogenic differentiation when stimulated with dexamethasone, L-ascorbate-2-phosphate, and inorganic phosphate [5].

Furthermore, it has been shown that SCAP are capable of differentiating into functional odontoblast-like cells in vivo, as demonstrated in animal implantation models. Thus, SCAP are similar to pulp progenitor cells, and if their potential can be harnessed, they could be induced to differentiate into pulp-like cells.

The proliferation of stem cells within the root canal system is mainly achieved through induction of bleeding from the periapical area, a process confirmed in 77% of studies [6, 7]. T.W. Lovelace demonstrated a 400–600-fold increase in mesenchymal stem cell markers in blood samples taken from root canals compared to levels found in systemic blood samples [8].

In this regard, a technique has been proposed that could utilize the potential of stem cells of the apical papilla, leading to the refilling of the root canal with vital tissue. The exact nature of the tissue that reoccupies the canal remains unclear, but it most likely consists of fibroblasts, blood vessels, and collagen [9].

Sodium hypochlorite at concentrations of 1–6% has been used either as the **sole irrigant** (in 65% of studies) or in combination with other irrigating solutions (in 97% of regenerative endodontic studies) [6]. This irrigant has been shown to be a potent antimicrobial agent capable of dissolving organic matter [10].

Some laboratory studies have examined the effect of different sodium hypochlorite concentrations (0.5%, 1.5%, 3%, and 6%), followed by either 17% EDTA (ethylenediaminetetraacetic acid) or saline solution, and reported the negative impact of high NaOCl concentrations on the viability and differentiation of stem cells from the apical papilla. Based on these findings, the use of 1.5% sodium hypochlorite followed by 17% EDTA was recommended [9].

After evaluating the effects of various irrigation combinations on apical papilla stem cells, it was found that the best cell survival rates were achieved after irrigation only with 17% EDTA. Therefore, the current recommended irrigation protocol in regenerative endodontic procedures is the use of 1.5% sodium hypochlorite followed by 17% EDTA, which should be the subject of future research [11].

For devital anterior teeth with incomplete root development and/or a wide-open apex, it is recommended to use $\text{Ca}(\text{OH})_2$ for a short period to achieve disinfection. This should be followed by the placement of mineral trioxide aggregate (MTA) to create an apical barrier, **obturation** of the root canal space with gutta-percha, and finally the placement of a well-sealed coronal restoration to prevent reinfection of the root canal system. There is sufficient evidence to recommend avoiding prolonged use of $\text{Ca}(\text{OH})_2$ in the canals of devital teeth with incomplete root development. Therefore, $\text{Ca}(\text{OH})_2$ apexification is no longer recommended as a primary treatment method for such teeth.

Conclusion

Currently, there is **insufficient evidence** to recommend **regenerative endodontic techniques (RET)** for routine use in the treatment of devital teeth with incomplete root development in children. However, attention should be given to this method, particularly in cases where **root development is**

severely incomplete, and even the use of mineral trioxide aggregate (MTA) may not improve the condition of the tooth.

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