IMPROVEMENT OF COMPREHENSIVE TREATMENT METHODS AIMED AT PRESERVING AND ENSURING THE FUNCTIONAL STATUS OF FIRST PERMANENT MOLARS WITH INCOMPLETELY FORMED ROOTS

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Abstract. First permanent molars (teeth 16, 26, 36 and 46) erupt at about six years of age, while their roots continue to form for a further three to four years. During this period the teeth are highly susceptible to caries, and deep lesions rapidly involve the wide, well-vascularised pulp. Loss of a first permanent molar in childhood leads to tipping and drifting of neighbouring teeth, overeruption of antagonists, reduced masticatory efficiency and malocclusion. The aim of this article is to review current evidence and to propose an improved comprehensive approach to the management of first permanent molars with incompletely formed roots, combining prevention, minimally invasive caries management, vital pulp therapy with calcium silicate-based materials, apexification and regenerative endodontic procedures, and structured long-term follow-up. A stage-based clinical algorithm is presented that links the choice of treatment to the stage of root development and to the condition of the pulp. The approach is intended for use in paediatric dental practice, including municipal children's dental polyclinics.

Keywords: first permanent molar; immature root; open apex; vital pulp therapy; pulpotomy; apexogenesis; apexification; regenerative endodontics; MTA; Biodentine; children.

Introduction

Dental caries remains one of the most common chronic diseases of childhood worldwide, and untreated caries of permanent teeth is among the most prevalent health conditions in the global population [1]. Among permanent teeth, the first permanent molars are the most frequently affected. They erupt early, often unnoticed by parents who mistake them for primary teeth; their occlusal surfaces have deep pits and fissures; and in the first years after eruption their enamel is not yet fully mature. In addition, developmental defects such as molar–incisor hypomineralisation (MIH) make these teeth particularly vulnerable to rapid breakdown [2].

Root formation of the first permanent molar is completed only at about nine to ten years of age [3]. Until then the tooth has thin dentinal walls, a wide root canal and an open apex. Such a tooth has a large regenerative potential, owing to its rich blood supply and the presence of stem cells of the apical papilla, but it is also mechanically fragile and difficult to treat with conventional endodontic methods. If the pulp becomes necrotic before the root is complete, root development stops and the tooth is left with short, thin roots and a poor long-term prognosis.

The consequences of premature loss of a first permanent molar extend far beyond a single tooth. The first permanent molars are the key teeth of occlusion: they take the main masticatory load and guide the eruption of the neighbouring teeth. After their extraction in childhood, the neighbouring teeth tip and drift into the gap, the antagonist overerupts, occlusal contacts are disturbed.

Consequently, the clinician's main task is not simply to remove infection but to preserve pulp vitality wherever possible, so that physiological root formation can continue, and to strengthen the tooth when vitality has been lost. The aim of this work is to summarise contemporary approaches and to propose an improved, comprehensive and stage-based treatment protocol for first permanent molars with incompletely formed roots.

Materials and methods

A narrative review of the literature on the management of immature permanent teeth was carried out, with emphasis on the first permanent molars. Clinical guidelines of the American Academy of Pediatric Dentistry, position statements of the European Society of Endodontology and the European Academy of Paediatric Dentistry, systematic reviews and key clinical studies were analysed [4–6]. On the basis of these data and of practical experience at the Olmaliq City Children's Dental Polyclinic, a clinical algorithm was formulated that links diagnosis, choice of treatment and follow-up.

Results and discussion

The treatment plan should be based on two parameters: the stage of root development and the condition of the pulp. Root development is assessed on periapical or bitewing radiographs (for example, according to Moorrees' stages [3]), noting root length, the thickness of the dentinal walls and the width of the apical foramen. Pulp status is determined from the history of pain, clinical examination, response to cold testing, percussion and palpation, and the presence of periapical radiolucency or a sinus tract. It should be remembered that sensibility tests are less reliable in immature teeth, so a decision is made on the combination of findings rather than on a single test.

The most effective way to preserve a first permanent molar is to prevent caries. Sealing of pits and fissures soon after eruption significantly reduces the incidence of occlusal caries in children and adolescents [7]. Where moisture control is difficult in a partially erupted molar, glass-ionomer sealants may be used as a transitional measure. Prevention also includes professional fluoride varnish application, hygiene instruction for the child and parents, dietary counselling and recall intervals adjusted to individual caries risk. Early detection of MIH allows protection of affected molars before post-eruptive breakdown occurs [2].

In deep lesions without signs of irreversible pulpitis, complete non-selective removal of carious dentine increases the risk of pulp exposure. Current consensus recommends selective removal of carious tissue, leaving soft or leathery dentine over the pulp and sealing it with a well-adapted restoration, or stepwise excavation [8, 9]. This approach reduces the frequency of pulp exposure and keeps the pulp vital, which is particularly important in teeth with immature roots.

When the pulp is exposed but still vital, vital pulp therapy is the treatment of choice. Depending on the extent of inflammation, a direct pulp cap, partial (Cvek-type) pulpotomy or full coronal pulpotomy is performed. The decisive clinical criterion is the ability to control pulpal bleeding with a cotton pellet moistened with sodium hypochlorite within a few minutes. Hydraulic calcium silicate cements such as mineral trioxide aggregate (MTA) and Biodentine have largely replaced calcium hydroxide, because they provide a better seal, induce a denser dentine bridge and are associated with higher success rates [10, 11]. Systematic reviews demonstrate favourable outcomes of pulpotomy even in cariously exposed permanent molars and in teeth with symptoms previously considered to indicate irreversible pulpitis [12, 13]. For immature molars, pulpotomy has a decisive advantage: the remaining radicular pulp continues to form the roots, producing thicker walls and a closed apex.

When the pulp is necrotic and the apex is open, the classical method was long-term calcium hydroxide apexification. Although effective in creating an apical barrier, it requires many visits over 6–24 months, and prolonged exposure to calcium hydroxide has been associated with weakening of root dentine and cervical fractures [14]. One-visit or short-term apexification with an apical plug of MTA or another calcium silicate material, 3–5 mm thick, followed by obturation and a sealing restoration, is now preferred [10, 15]. It shortens treatment time and improves patient cooperation, but it does not increase root length or wall thickness.

Regenerative endodontic treatment (revascularisation) aims to restore vital tissue in the canal and to allow continued root development. The protocol includes gentle irrigation with low-concentration

sodium hypochlorite and EDTA without mechanical instrumentation, intracanal medication with calcium hydroxide or a low-concentration antibiotic paste, and at the second visit induction of bleeding from the periapical tissues to form a blood-clot scaffold, which is covered with a calcium silicate material and a coronal seal [16–18]. Successful cases have been reported in necrotic immature molars [19]. Regenerative treatment is most indicated in teeth with very short roots and thin walls, whereas apexification remains a reliable choice when the root is nearly complete or when patient cooperation is limited.

The long-term success of any of these methods depends on a hermetic coronal seal. After vital pulp therapy or endodontic treatment, molars should be restored with bonded composite restorations or, in extensively destroyed teeth and MIH-affected molars, with preformed metal crowns. Clinical and radiographic follow-up is carried out at 3, 6 and 12 months and then annually until root formation is complete. Indicators of success are the absence of symptoms, normal periapical tissues, formation of a dentine bridge and continued root development.

On the basis of the analysed data, the following stage-based approach is proposed: (1) for sound or initially affected molars – fissure sealing, fluoride varnish and individual caries-risk recall; (2) for deep caries with a vital, reversibly inflamed pulp – selective caries removal or indirect pulp capping with a calcium silicate liner; (3) for pulp exposure with controllable bleeding – partial or full pulpotomy with MTA or Biodentine; (4) for necrotic pulp with a very immature root – regenerative endodontic treatment; (5) for necrotic pulp with a nearly completed root or failed regeneration – MTA apical plug apexification; (6) in all cases – a durable coronal restoration and scheduled follow-up. Extraction is considered only when the tooth cannot be restored, and in that case its timing should be planned together with an orthodontist to allow spontaneous space closure by the second molar.

Conclusion

First permanent molars with incompletely formed roots require a differentiated, comprehensive approach that begins with prevention and is based on the stage of root development and the condition of the pulp. Preservation of pulp vitality with minimally invasive caries management and vital pulp therapy using calcium silicate cements offers the best chance of completing root formation. For non-vital immature molars, regenerative endodontic procedures and MTA apexification are effective, complementary alternatives. Introduction of the proposed algorithm into the work of children's dental polyclinics can increase the number of first permanent molars preserved in a functional state and reduce the frequency of their premature extraction.

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