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Pathology and Abnormality of the First Permanent Molar among Children

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Abstract

The first permanent molar (FPM) plays an essential role in the masticatory function by contributing to the implementation and the maintenance of the occlusion. However, it is considered as the most frequently affected and the earliest affected tooth by caries; 27.4% of the 6–8 years old children have developed at least one cavity on one of the four first permanent molars, according to a study conducted among 3276 school children in Casablanca. Therefore, the FPM should benefit from special vigilance on the part of the practitioner to ensure that any early carious lesion is intercepted. In addition, the FPM, due to its period of mineralization coinciding with early childhood diseases, can erupt with a structural abnormality. Molar incisor hypomineralization (MIH) is considered to be the most common defects observed on first permanent molars among children. A study conducted among 1077 children aged 7–10 years enrolled in schools in Casablanca showed that 7.9% of children were affected with MIH. About 84.7% of the children had the four molars affected. Children with HIM had a significantly higher prevalence of caries: 78.8 versus 33.5%. These structural abnormalities of the enamel must be carried out earlier to ensure that the coronary anatomy is the least compromised.

Keywords: molar, dental caries, risk factors, therapeutic, prevention measures, molar incisor hypomineralization, tooth abnormalities, dental care for children, Morocco

1. Introduction

The first permanent molar (FPM) is considered as the most important tooth for the dentition and dental development with a key role in occlusion. It participates in the maxillary growth and physiology of the mandibular system.

However, it is considered to be the most and earliest affected tooth by cavities. Indeed, the early time of its eruption when hygiene is difficult and poorly controlled makes it particularly vulnerable to carious disease.

In addition, FPM, due to its period of mineralization coinciding with early childhood diseases, can erupt with a structural abnormality. Molar incisor hypomineralization is considered to be the most common defect observed on FPM in children.

Other uncommon abnormalities can affect the FPM such as shape, size, or eruption abnormalities. The early diagnosis of lesions on this tooth allows in a large number of cases to avoid complications and the systematic use of endodontic and prosthetic treatments and sometimes even tooth extraction.

The purpose of this chapter is to review the main pathologies and abnormalities of the first permanent molar. Epidemiological data, risk factors, clinical aspects, therapeutic, and preventive approach are described and illustrated by clinical cases treated at the Casablanca Pedodontics Department.

2. Carious pathology of the first permanent molar

2.1 Epidemiology and risk factors

The importance of the carious pathology of the first permanent molar has been known clinically for a long time. Epidemiological surveys carried out in several countries have shown the extent of this problem [1–5]. In France, in 2007, a survey on the oral health of 12–15 years old children attending school in the southern province revealed that 52.4% of children had already carious disease and 11.9% have four FPM affected teeth [1]. In 2015, Xue et al. reported, in Tangshan (China), a prevalence of caries of 47.49% on the FPM. Another study conducted among Sudanese children showed a prevalence of 6-year-old tooth disease of 61% [2, 3].

In Morocco, epidemiological surveys were carried out to determine the state of the FPM among schoolchildren and consultants in the Pedodontic Department in the Universities of Hassan II of Casablanca and Souissi of Rabat. They all showed a high rate of decay in the FPM [6, 7].

Indeed, a descriptive cross-sectional study of 3276 children aged 6–8 years enrolled in school in Casablanca revealed that 27.4% had at least one cavity in one of the four FPMs [6].

A survey of 216 children aged 6–13 years old who were consultants in the Pedodontics Department in the University of Hassan II of Casablanca showed that 73.14% of subjects had at least one FPM affected by cavities and 12.65% of subjects had all four teeth affected [8]. As in the Pedodontics Department of the University of Suissy of Rabat, 65% of children aged 6–15 years had at least one carious FPM [7]. The prevalence of caries increases with age, and this is in accordance with studies carried out by Al-Samadani and Ahmad [2] and Aldossary et al. [9] in Saudi Arabia. Most of these studies showed that the first mandibular molars were statistically more affected than their maxillary counterparts ($p < 0.01$) [8, 9].

In the permanent dentition, first permanent molar was observed to be highly susceptible to carious lesions in its occlusal aspect due to the early time of its eruption, to its morphological characteristics and to its positioning in the oral cavity [10–12].

First permanent molar is the first permanent tooth appearing in the child's mouth; most parents are unaware that these teeth are the first permanent teeth and often neglect its importance considering it a primary insignificant tooth [13]. Sometimes, parents think that the first permanent molar is a deciduous tooth, and instead of restoring it, they extract the tooth and deprive the child of the right to permanent teeth in the future [14].

Regarding parents of children consulting in the Pedodontic Department in the University of Hassan II of Casablanca, only 19% of them know that this tooth is permanent. The others do not know when it erupted and confuse it with a temporary molar [8]. According to the study by Heydari et al., most parents are unaware of the presence of FPMs in their children's oral cavity [14].

The first permanent molar has a longer eruption time. Carvalho and Abernathy found that the first permanent molars were more susceptible to caries during the first 1–3 years after the eruption and the occlusal aspects of the first permanent molars were particularly vulnerable to the caries development at the age of 6 [15].

The complicated pits and fissures and the operculum covering the distal half of the first permanent molars allow for the accumulation and retention of bacterial plaque [16–18]. Favorable conditions for biofilm accumulation during tooth eruption are likely to explain, at least in part, the present findings. First, the amount of biofilm accumulated on the occlusal aspects has been shown to be higher in partially erupted molars than in fully erupted molars. In addition, Brailsford et al. showed the qualitative differences in the biofilm composition, with partially erupted teeth having higher counts of non-mutans streptococci and *Actinomyces israelii* than fully erupted teeth [19].

Besides, first permanent molar exhibits an increased susceptibility to caries due to its positioning in the oral cavity in the posterior region of the child's mouth which makes it further difficult for the child to properly clean this area [19, 20].

The first permanent molars are at greater risk of damage and loss, because of their special morphology. Pits and fissures on occlusal aspects of permanent teeth are particularly susceptible to the development of tooth decay. This susceptibility to tooth decay is related with the individual morphology of the tooth's pits and fissures, which can be prosperous shelters for microorganisms and make the oral hygiene procedures of these areas more difficult, allowing greater plaque accumulation [21].

Many surveys have reported a preferred site of mainly occlusal caries: 90% of caries occurs at this level in children and adolescents [22]. The same results were found at the Pedodontics Department in the University of Hassan II of Casablanca, where 87.7% of the FPM caries were found in the occlusal grooves [8].

The occlusal fissured surface of the first permanent molars and their lower buccal and upper lingual pits are among the most susceptible sites for caries.

Waterman and Knutson believed that first permanent molars especially lower molars among the other teeth are most susceptible to caries [13].

In the survey of Alwayli et al., the caries prevalence in the mandibular FPMs was significantly higher than the caries prevalence in the maxillary FPMs. This finding is in agreement with other studies [23, 25]. The reason expected behind this finding is the difference in the morphology and the earlier eruption time of mandibular compared with maxillary FPMs.

On the other hand, caries in primary molars is an important indicator for the development of cavities in the permanent dentition, particularly in the first molar teeth [24, 25]. The severity of the caries of primary molars may also increase the risk of caries in the early erupting stage of the first permanent molars [26]. According to Gray et al., the presence of three or more deciduous molars with caries at the age of 5 years was the best predictor of caries experience in the first permanent molars at the age of 7 years [27].

The increase in the prevalence of dental caries is a result of dietary changes, including frequent consumption of high-energy, low-cost foods that are poor in nutrients and rich in sugar and fat and unbalanced consumption of sugar content. The consumption rate of sweet foods for children aged 6–11 years increased from 23.1% in 2002 to 43.9% in 2012 [28, 29].

2.2 Clinical forms and complications

The caries of FPM in children is characterized by its precocity and speed of evolution, due to the immaturity of the tissues that compose it. The carious lesions,

often active in children, will evolve insidiously towards the chronic inflammation of the pulp and eventually towards the pulp necrosis, which can compromise the root edification. As a result, early diagnosis is essential [30].

The clinical examination includes both a visual examination under good lighting and a tactile examination. Visual examination can detect advanced lesions, initial lesions usually go unnoticed. Tactile examination allows sounding, useful for the detection of dentinal hardness of cavitary lesions, but is found to be iatrogenic in the detection of initial lesions [31].

In 2005, a consensus conference proposed to rationalize the visual signs of detection of carious lesions in the form of a codified system, the ICDAS (International Caries Detection and Assessment System), which gives an idea of the demineralized tissues and which, therefore, allows a therapeutic adapted to the tissue damage [32]. This system contains seven codes from 0 (healthy tooth) to 6 (extended dentin caries) [33] (<http://www.icdas.org>) (**Table 1**).

The ICDAS classification allows a visual diagnosis. However, it should not be limited to this criterion alone; an assessment of lesion activity is required. It is based mainly on two clinical indicators; the presence of plaque related to the localization of the lesion and the tactile sensation to the sounding [33–36].

FPM caries are mainly located on the occlusal aspects of the tooth. There are, in particular, two clinical forms of predominant carious lesions: cavities in grooves, pits, and fissures, and hidden or surprise carie. At the proximal level, more rarely, another form of caries called stopped is observed [37, 38].

The decay of grooves, pits, and cracks begins at the bottom of the crevice. The complex anatomy of pits and fissures and the presence of discoloration can complicate both clinical examination and diagnosis. Indeed, early lesions may not be clinically and radiographically visible, and their early diagnosis will require new diagnostic techniques based on fluorescence [34–37].

Hidden carie is the characteristic of immature FPM. It is located on the occlusal aspect of the tooth and develops in the pulpal direction by extending in width under the surface of the enamel, which appears intact. This evolution is very often done without painful clinical signs. Detection, often very late, is done during a routine clinical examination, when a small pertuis attaches to the probe. The radiograph reveals, in a surprising way, the extent of the dentinal damage compared with the usual clinical aspect of the caries [38, 39] (**Figure 1**).

Mesial caries is often related to the progressive caries of the distal surface of the second temporary molar. The fall or loss of this molar will allow a better hygiene of the region and the initial carious lesion by remineralizing it which can be transformed into an arrested lesion [39, 40] (**Figure 2**).

In the absence of treatment of the active carious lesions, the inflammation insidiously gains the young pulp and evolves rapidly towards the necrosis. This necrotic state compromises the continuation of root edification. Infectious problems can settle and spread to the cellulo-adipous tissues. The evolution of cellulitis can be acute or chronic.

Serious cellulitis is the initial essentially inflammatory stage. It is characterized by an important swelling, a feeling of impasto and diffuse heat, a spontaneous pain, a trismus, a very painful percussion, and a positive buccal palpation.

Suppurative acute cellulitis is the progressive form of serious cellulitis in the absence of treatment. It is characterized by the abcedation with appearance of general signs: trismus, insomnia, difficult feeding, asthenia, sometimes aches, paleness, fever, throbbing pain accompanied by headache, and feeling of beatings at the swelling. The collection can be fistulized to the oral mucosa or to the skin. It can also spread to nearby anatomical compartments and become a diffuse cellulitis that is life-threatening [41, 42].

ICDAS classification		Histological involvement	
0		No demineralization
1	Visible change after drying	Demineralization limited to the external half of the enamel
2	Visible change without drying	Demineralization limited to the internal half of the enamel
3	Localized rupture of the enamel without demineralization of the underlying visible dentin	Damage of the dentino enamel junction. Start of external demineralization of dentin
4	Carious dentin visible by transparency with or without localized rupture of the enamel	external demineralization of dentin
5	Visible micro-cavity with visible dentin	demineralization of the middle third of dentin
6	Extended dentin caries	Demineralization of the deep third of dentin

Table 1.
ICDAS classification.

Figure 1.
Hidden carie on the tooth 36, with preservation of an enamel veil.

Figure 2.
Stopped caries: initial caries in mesial of the 46, likely to remineralize after the fall of the 85.

The evolution towards chronicity can be following a badly treated bad cellulitis. It is characterized by a painless swelling on palpation, adhering to the skin with the presence of an indurated cord. Chronic cellulitis evolves irreversibly, with no general or functional signs [42] (**Figure 3**).

2.3 Therapeutic approach

The therapeutic management of caries of FPM should be done according to the principle of tissue economy to respect the healthy hard tissue and to preserve pulp vitality in case of deep carious lesions.

Nowadays, the evolution of dental restoration techniques and materials provides us different therapeutic possibilities to deal with the carious lesions. The International Caries Detection and Assessment System (ICDAS) allows a treatment adapted to tissue involvement according to the dental demineralization degree [43].

- Remineralization techniques will be performed on ICDAS 1 and 2 by topical application of fluoride on smooth surfaces and furrow sealing in grooves [44].
- For cavitary lesions (ICDAS 3 and 4), the treatment will involve minimally invasive dentistry by using microdrills, aeroabrasion for occlusal cavities, and sonoabrasion for inter-proximal cavities. The filling materials used are flowable composite resins (small cavities) or micro-hybrids (wider cavities).
- For ICDAS 5 and 6, the symptomatology must be taken into consideration for the therapeutic management of these lesions.

Figure 3.
Chronic cellulitis related to necrotic 36 in a 9-year-old child.

In case of deep decay that does not reach the pulp with the absence of clinical signs, the treatment of choice is indirect pulp capping which can be done in one step by removing the external area of the infected dentin, leaving a layer of firm internal affected dentin in order to avoid pulp exposure during caries removal. A calcium hydroxide is used as a base followed by a final coronal restoration [45].

Another approach can also be proposed, the “stepwise excavation” technique. It consists in cleaning the cavity in two steps with 3–6 months interval [45]. The tooth decay is incompletely removed at the bottom of the cavity, a calcium hydroxide is placed then a temporary, and hermetic sealing is performed by permitting the remineralization and the development of tertiary dentin [46]. A few months later, in a second step, the intervention will remove the remaining carious tissue and leaving the place for a harder dentin with the characteristics of an inactive lesion [45–47]. Stepwise excavation decreases the risk of pulp exposure compared with direct complete excavation.

In a randomized clinical trial Bjorndal et al. (2010), it showed a survival rate of 74% after 1 year of SW compared with 62.4% after selective removal to firm dentin [48].

If a pulp exposure occurs following dental excavation, a direct pulp capping will be indicated in case of a spontaneous bleeding stop [46] (**Figures 4 and 5**). Calcium hydroxide was widely used, but currently, the mineral trioxide aggregate and Biodentine are recommended with excellent clinical and radiographic results up to 6 months, 1 year, and even 2–3 years for some studies [49–51].

If the FPM is symptomatic, pulp vitality is compromised and a pulp treatment should be interesting either part or all of the cameral pulp. These pulp treatments are universally accepted on young permanent teeth [46, 52].

The pulpotomy procedure involves removing pulp tissue that has inflammatory, leaving intact the remaining vital non-inflamed tissue, which is covered with a pulp capping agent to promote healing at the amputation site. Usually, pulpotomy consists in removing the entire coronal pulp up to the cervical area. Today, the depth of tissue removal is based on a clinical view, only tissue with profuse bleeding judged to be inflamed or infected should be removed, and the capping material should be placed on healthy tissue. MTA and biodentine seem to be the treatment of choice to stimulate dentin bridge formation in young permanent teeth with exposed pulps [51–53].

There is a controversy as to the indications for performing root canal treatment after root maturation. Prophylactic endodontic treatment is not recommended because of the low percentage of pulp necrosis [54]. It is important to perform a permanent restoration to prevent bacterial leakage and ensure the success of the treatment.

Figure 4. Direct pulp capping on the right first permanent immature molar. (a, b) Deep caries close to the pulp. (c, d) Direct pulp capping with calcium hydroxide after pulp exposure. (e, f) Radiographs after 6 and 18 months of treatment showing good evolution and apexogenesis.

There should be no adverse clinical signs or symptoms such as sensitivity, pain, or swelling. There should be no radiographic sign of internal or external resorption, abnormal canal calcification, or periapical radiolucency post-operatively. Teeth having immature roots should continue normal root development and apexogenesis.

For the first immature permanent molars whose pulp is no longer vital or necrotic, apexification treatment is undertaken to induce development and apical closure. It can be achieved in two manners, either as a long-term procedure using calcium hydroxide dressing to allow the formation of a hard tissue barrier (**Figure 6**), or as a short-term procedure creating an apical plug of MTA [52]. Although calcium hydroxide has properties including bactericidal action on aerobic and anaerobic germs to heal periapical lesions [55, 56] (**Figure 7**), it has some inconveniences related to a long-term treatment and a high-risk of root fracture of permanent immature teeth.

Figure 5.
Direct pulp capping on the left first permanent molar. (a) Deep caries with pulpal involvement on the 36 asymptomatic. (b) Direct pulp capping with biodentine. (c) Radiograph after 6 months of treatment showing favorable evolution.

Figure 6.
Apexification of the 36. (a) Deep caries reaching the pulp with peripical apical lesions on the immature tooth. (b) Endodontic treatment and root canal filling with calcium hydroxide. (c) Radiograph after 6 months of treatment showing the favorable evolution and regression of periapical lesions. (d) Final root canal treatment with gutta-percha after apical closure achieved after 2 years.

Despite the success of apexification, the canal walls remain short and thin increasing the fracture risk of the tooth.

Recently, revascularization has been proposed as an alternative procedure to treat the necrotic immature permanent teeth with open apex regardless the periapical pathology. It is based on the elimination and the replacement of infected necrotic pulp by a neoformed tissue. Indeed, the use of the capacity of stem cell

Figure 7.

Treatment of periapical lesions of the left first permanent molar. (a) Deep occlusal caries on 36 with abscess facing the tooth. (b) Retro alveolar showing pulp involvement by decay and significant periapical lesions on the mature tooth. (c) At 3 weeks of root canal treatment with calcium hydroxide, regression of periapical lesions. (d) Final root canal treatment.

differentiation could allow a reconstruction of dental structures, root development, and apical closure [57–59] (**Figure 8**).

Early diagnosis of carious lesions and the application of appropriate preventive measures will avoid the use of heavy and often expensive dentine-pulpal treatments.

2.4 Preventive approach

The time between the eruption of the first permanent molars and the establishment of functional occlusion is a critical period to protect the permanent teeth from caries. Prevention should begin as soon as the first permanent molar erupts rather than wait until the eruption is completed.

These facts dictate the need for caries-prevention technology, targeted at the most susceptible tooth surfaces in the most susceptible members of the population. First permanent molars need special attention; thus, careful preventive strategies include fissure sealant, topical fluoride applications, and meticulous home care [60, 61].

Fissure sealants used on occlusal tooth surfaces were introduced in 1960s for protecting pits and fissures from dental caries. Such sealants prevent the growth of bacteria that promote decay in pits and fissures in teeth (**Figures 9 and 10**).

The application of fissure sealants should be complemented with oral health education for children, adolescents, and their families to assimilate adequate oral hygiene habits and understand the need of regular dental appointments for primary prevention and early diagnosis of oral diseases [21].

There is an agreement that in high-risk populations, all children should receive sealants [62, 63].

Several sealant materials are available. Currently, the two pre-dominant types of dental sealant nowadays are resin-based and glass ionomer cement (GIC) sealants.

Figure 8. Revascularization treatment on the left first permanent molar [58]. (a) Clinical status of the 36 with temporary coronal obturation. (b) Peroperative radiography: short immature roots with periapical radiolucency. (c) 3 weeks after canal disinfection and blood clot, MTA was applied and stainless steel crown was placed. (d) 10 months follow-up, periodontal healing, with the disappearance of radiolucency from the mesial root canal. (e) 14 months follow-up: thickening of the root and beginning of canal obliteration.

For high-quality resin sealant placement, electrically powered dental equipment and good clinical conditions are required. However, this may be difficult to achieve in regions, where access to modern dental clinics is limited. This problem may be overcome by using GIC sealants because they can be placed without the use of electrically powered dental equipment [64].

When considering fissure sealants, the earlier the application is performed, the more effective they are. Therefore, in children, fissure sealants are recommended to be applied soon after tooth eruption, mainly at the level of the first permanent molars. Studies have shown that fissure sealants applied both in clinics and schools are highly effective in preventing dental caries, reducing caries in pits and fissures up to 60% for 2–5 years after its implementation [65].

Numerous studies have investigated the clinical effectiveness of fissure sealants, and this has been the subject of a Cochrane review. A meta-analysis of seven studies

Figure 9.

First permanent molar with deep pits and fissures and important accumulation of plaque.

Figure 10.

After sealant application.

comparing sealed teeth to untreated controls demonstrated caries reductions ranging from 87% at 12 months to 60% at 48–54 months [66].

Several studies have demonstrated that the effectiveness of fissure sealants depends on the longevity of sealant coverage, that is, clinical retention [20].

In terms of retention and the need to reassess sealants within a year after placement, it is very important to adequately isolate the teeth. Salivary contamination is the major cause of sealants loss in the first year [67, 68].

The retention of resin sealants was good on average in all studies at each follow-up. After 12 months of follow-up, resin sealants were retained completely in 79–92% of cases. The corresponding retention after 24 and 36 months of follow-ups for resin sealants was 71–85 and 61–80%. There is an evidence in the literature regarding fissure sealants' effectiveness in caries prevention and control, for both individual and community-based interventions for children and adolescents [20, 69–71].

In field conditions where isolation control is difficult, using a material less affected by humidity, it gives significant advantage [72]. In fact, fissure restorers with glass-ionomer-based chemical hardening feature applied in recent years in field conditions displayed a better cavity prevention performance compared with antiresins [73].

Fluoride varnishes have also been marketed since 1960s and comprise a topical medication, which is painted onto the tooth surface. They contain a high concentration of fluoride (22,600 ppm) and are licensed for application by dental professionals. The varnish forms a quick-setting base which subsequently releases fluoride.

The aim of topical fluoride varnish application is to treat hard tooth surfaces in such a way that caries is arrested or reversed. Fluoride acts to prevent caries in three ways: by inhibiting the demineralization and promoting the remineralization of dental enamel, and by inhibiting acid formation by bacterial plaque especially before the complete eruption of the teeth.

Sometimes, topical fluoride has been combined with sealant application to strengthen overall effectiveness in the prevention of dental caries [74].

At the end of 4 year period, Songpaisan et al. based on a study conducted in Thailand found that pit and fissure restorers provided a much more superior protection than fluoride protocols applied individually. It was also seen that glass ionomer fissure restorers provided a better protection than the fluoride gel [75].

Data from three randomized controlled trials suggest that in children and adolescents with sound occlusal surfaces, the use of pit and fissure sealants compared with fluoride varnishes may reduce the incidence of occlusal carious lesions in permanent molars by 73% after 2–3 years of follow-up (OR, 0.27; 95% CI, 0.11–0.69) [76].

3. First permanent molar abnormalities

Several factors can disrupt the development of PMP. Depending on when these disturbances occur, anomalies in number, shape, size, or structure may be observed.

Among these, MIH remains the most commonly encountered and described anomaly today.

3.1 Molar-incisor hypomineralization

3.1.1 Epidemiology

Molar incisor hypomineralization, conventionally known by the acronym MIH, corresponds to the qualitative defects of the enamel, of systemic origin, affecting one or more first permanent molars, often associated with defects on one or more incisors [77].

The involvement of the second temporary molars and cuspidian tip of the permanent canines has also been described [78].

The prevalence of MIH varies considerably according to studies ranging from 2.4% in Germany [79] to 2.5% in China [80] and to 40% in the United Kingdom [81]. In Africa, studies in Libya, Morocco, Kenya, and Nigeria reported the prevalences of 2.9, 7.9, 13.7, and 17.7%, respectively [82–85]. According to a recent meta-analysis published in 2018 [86], the global average prevalence is 13.1% with 17.5 million new cases estimated in 2016, of which 4.8 million require management.

While the prevalence of MIH is comparable between the two sexes [82, 87], the location of defects by arch and by sector remains variable. It seems that the risk of incisor damage increases with the number of molars affected. Cho et al. reported, in 2008 [80], an incisor participation of 62.5% for cases with the four affected molars versus 36% for children with single molar involvement. In a study conducted in Casablanca [82], the high number of children with the first four permanent molars affected (84.7%) may explain the high incisor participation found (92.94%).

3.1.2 Risk factors

The precise etiology of MIH stills unknown. The probable systemic origin is probably multifactorial and with a possible genetic component. The pre-natal factors involved are urinary tract infections, vitamin D deficiency, and the use of antiepileptic medications during pregnancy. In the perinatal period, we could note cesarean delivery, delayed delivery, and prematurity. Post-natal causes are related not only to early childhood diseases such as repeated fevers, ear infections, pneumonia, asthma, and gastrointestinal disorders, but also the exposure to bisphenol A or dioxin and frequent use of antibiotics [88–90].

3.1.3 Diagnosis

The clinical aspect of the lesions is characteristic. These lesions are white, yellow, or brown opacities, well-defined with a clear demarcation between the affected enamel and the healthy one. They are located in the occlusal and/or incisal third, which may extend over a more or less important area of the coronary surface. These lesions are asymmetrical and the severity of the lesions is very variable. In severe cases, the affected molars suffer from masticatory forces, a post-eruptive fracture of the fragile enamel resulting in substance loss, hypersensitivity, and the development of carious lesions. Affected incisors, often unsightly, have fewer complications [77, 78, 91] (**Figure 11**).

In order to standardize and facilitate the diagnosis of MIH, the European Association of Pediatric Dentistry (EAPD) has been adopted, since 2003, five criteria that are the presence of delimited opacities, post-eruptive enamel loss, atypical restorations, extraction of first molars associated with incisor damage in a patient at low risk of caries, and the absence or delay of eruption of first molars or permanent incisors [92].

Since 2016, an international working group, the Wurzburg MIH work group, has been introduced the MIH treatment need index (MIH TNI) to assess the severity of MIH with a score based on the presence or absence of sensitivity and the extent of clinical destruction with the ultimate objective of proposing a therapeutic approach based on this index [93].

The MIH should not be confused with other structural abnormalities of the enamel, whether of hereditary or acquired origin, namely imperfect amelogenesis, fluorosis, and especially enamel hypoplasia, for which the limits of substance loss are rounded and bordered by a well-mineralized enamel, unlike the MIH where the edges of substance loss are sharp and bordered by a hypermineralized enamel [94].

3.1.4 Treatment

The management of MIH is a real challenge for the practitioner for several reasons. The affected teeth are difficult to anesthetize because the pulp has histological

Figure 11.
(a, c) MIH involving the four FPM with post-eruptive fracture and carious complication in an 11-year-old patient suffering from a digestive disease. (b) Asymmetrical lesion of tooth 11 with white opacities, well-defined and located in the incisal third of coronary surface.

features responsible for chronic inflammation, most often requiring the use of truncular, intra-ligamentary, or transcortical anesthesia. The limits of the preparation during caries excavation are difficult to determine since the practitioner remains divided between the desire not to be too invasive and the need to remove all the hypomineralized enamel to ensure the durability of the restorations. The anxiety of patients suffering, on the one hand from hypersensitivity to hot, cold, and tooth brushing and on the other hand from repeated care due to the more delicate adherence to the enamel structure, remains difficult to manage and often involves the use of conscious inhalation sedation [78, 95].

Several therapeutic options are possible depending on the patient's age and cooperation, the severity of the disease, pulp involvement, orthodontic diagnosis, long-term prognosis, and the cost of treatment [96].

For mild abnormalities with a smooth enamel surface, the application of fluoride varnish and sealing of the grooves is recommended (**Figure 12**). When abnormalities are moderate with one or both affected surfaces without affecting the cusps, the teeth are restored with the composite by direct method [97].

In the case of severe MIH, direct restoration has certain mechanical limitations and perfect restoration of the tooth anatomy is difficult to achieve. Preformed pedodontic copings (PPC) and bonded indirect partial restorations (BIPR) in the form of onlays, overlays, or inlays are then indicated (**Figure 13**). PPCs remain simpler to implement, less expensive with a high success rate. However, they must be replaced by a peripheral crown in adulthood. For BIPRs, they are made using composite or ceramic materials in two stages or even in a single session if computer-aided design and manufacturing (CAD/CAM) is used. In young patients, composite BIPRs are preferred because it allow repairs by direct composite addition, allow thinner restorations, present less risk of fracture, and their esthetic appearance remains satisfactory [96].

For very severe abnormalities, it is sometimes more appropriate to extract the tooth. Nevertheless, it will be necessary to choose the ideal moment to allow the second permanent molar to make a spontaneous mesial eruption instead of the first extracted molar. This moment corresponds to the period of formation of the furcation zone of the second permanent molar visible on a panoramic radiograph. However, orthodontic consultation is recommended [98, 99].

The MIH remains a frequent, progressive abnormality that can lead, in the absence of treatment, to the total destruction of the tooth. Thus, only early diagnosis, adequate care, and regular follow-up can keep the 6-year-old tooth on the arch and allow it to play its full role in children.

3.2 Other abnormalities of the first permanent molar

The FPM may be affected by other rare abnormalities: anatomical, eruptive, or agenesis.

Figure 12.
(a) MIH involving the upper FPM in a 6-year-old patient with HIV infection. (b) Sealing of the grooves and application of fluoride varnish.

Figure 13.
(a–c) Severe MIH with incisive involvement in an adolescent with mental retardation. The four FPM are affected with post-eruptive fracture on 16, 36, 46, and carious complication. (d–f) Reconstruction under conscious sedation of teeth 16, 36, and 46 using preformed pedodontics caps after the preservation of pulpal vitality by indirect capping. Restoration of teeth 21 and 26 with the composite by direct method. (g) Radiographic control of lower left sector.

3.2.1 Anatomical abnormalities

The first upper molar has a very stable anatomy with strongly expressed anatomical characteristics. However, some variations have been described for the Carabelli's tubercle; mesio-distal accessory cuspidian tubercle can have a high variability in shape and volume [100].

The Bölk tubercle, which is sometimes present on the buccal aspect of the tooth or at the mesio-buccal angle of the second upper molar, can exceptionally be observed on the upper FPM (**Figure 14**). The presence of an accessory root can be associated with a large Bölk tubercle (**Figure 14b**).

As for the lower FPM, it may have anatomical variabilities that mainly concern the number of cusps, which can vary from four to seven cusps instead of the usual five cusps [100] (**Figure 15**).

These morphological abnormalities can interfere with good oral hygiene and are a factor in susceptibility to carious disease. Early diagnosis allows the implementation of preventive measures based on sealant.

Root abnormalities are quite numerous, either in direction and number or in shape and size. Taurodontism is also a particular variety of root-shaped abnormalities (**Figure 16**).

3.2.2 Eruption abnormalities

Ectopic eruption of the FPM is a phenomenon that affects 3–4% of the population and is mainly observed in the upper FPMs [101].

Figure 14.
(a) Very developed Bôlk tubercle on the mesio-buccal angle of the upper FPM in an 11-year-old girl. (b) Accessory root associated with this wide tubercle.

Figure 15.
Lower FPM with an unusual number of cusps and grooves.

Figure 16.
The four FPMs and the second temporary molars have taurodontism.

It corresponds to an evolution according to an abnormal mesial trajectory, thus causing the pathological resorption of the disto-buccal root of the adjacent second temporary molar.

Interception of the ectopic eruption of the FPMs is essential to avoid permanent tooth blockage and the loss of space prejudicial to the eruption of adjacent premolars causing malocclusions [102].

Inclusion is the most common eruption abnormalities encountered. Its incidence varies from 5.6 to 18.8%. The upper canines, FPMs, and lower lateral incisors are the most prone to inclusion [103]. The inclusion of FPMs can be isolated or associated with complex syndromes (**Figure 17**).

Figure 17.
Retention of FPMs in an 8-year-old girl with an unlabeled syndrome.

Figure 18.
12-year-old patient with agenesis of lower FPM, lower incisors, and upper lateral incisors.

3.2.3 Agenesis

Agenesis consists in the absence of the development of a dental germ. The prevalence of dental agenesis varies from 3.4 to 10.1% depending on the country. It mainly affects the permanent teeth. The most frequently affected teeth are the lower second premolars, upper lateral incisors, and upper second premolars.

The agenesis of superior FPMs is rare with a prevalence of 0.01–0.04% [104]. It can be observed in the context of oligodontics associated with rare diseases (Figure 18).

4. Conclusion

The vulnerability of the first permanent molar exposes it very early to carious disease and its complications.

Therefore, in children, this tooth must be given special attention by the practitioner in order to assess the carious risk, detect and intercept any early lesion, provide appropriate treatment, and ensure regular follow-up.

Collective prevention measures in schools are also needed to reduce the prevalence of carious disease.

Conflict of interest

There is no conflict of interest.

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