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Review article

Managing molar-incisor hypomineralization: A systematic review

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ABSTRACT

Objectives: We systematically reviewed treatment modalities for MIH-affected molars and incisors.
Data: Trials on humans with ≥1 MIH molar/incisor reporting on various treatments were included. Two authors independently searched and extracted records. Sample-size-weighted annual failure rates were estimated where appropriate. The risk of bias was assessed using the Newcastle-Ottawa scale.
Sources: Electronic databases (PubMed, Embase, Cochrane CENTRAL, Google Scholar) were screened, and hand searches and cross-referencing performed.
Study selection: Fourteen (mainly observational) studies were included. Ten trials (381 participants) investigated MIH-molars, four (139) MIH-incisors. For molars, remineralization, restorative or extraction therapies had been assessed. For restorative approaches, mean (SD) annual failure rates were highest for fissure sealants (12[6]%) and glass-ionomer restorations (12[2]%), and lowest for indirect restorations (1 [3]%), preformed metal crowns (1.3 [2.1]%) and composite restorations (4[3]%). Ony study assessed extraction of molars in young patients (median age 8.2 years), the majority of them without malocclusions, but third molars in development. Spontaneous alignment of second molars was more frequent in the maxilla (55%) than the mandible (47%). For incisors, desensitizing agents successfully managed hypersensitivity. Micro-abrasion and composite veneers improved aesthetics.
Conclusions: Few, mainly moderate to high-risk-studies investigated treatment of MIH. Remineralization or sealants seem suitable for MIH-molars with limited severity and/or hypersensitivity. For severe cases, restorations with composites or indirect restorations or preformed metal crowns seem suitable. Prior to tooth extraction as last resort factors like the presence of a general malocclusion, patients' age and the status of neighboring teeth should be considered. No recommendations can be given for MIH-incisors.
Clinical significance: Dentists need to consider the specific condition of each tooth and the needs and expectations of patients when deciding how to manage MIH. Strong recommendations are not possible based on the current evidence.

1. Introduction

Non-endemic mottling of enamel, internal enamel hypoplasia, cheese molars, non-fluoride enamel opacities, idiopathic enamel spots or opacities are all different terms used to describe the condition currently known as molar-incisor hypomineralization (MIH) [1]. MIH is defined as demarcated, qualitative developmental defects of systemic origin of the enamel of one or more permanent first molar with or without the affection of incisors [2–4]. The clinical characteristics of MIH vary both between and within patients [2,3]. The prevalence of MIH is relatively high, and is reported to range from 3 to 22% in Europe [5–7].

A number of etiological hypotheses for MIH have been postulated. Prenatal exposures (like maternal smoking or illness during pregnancy), perinatal exposures (like premature or prolonged birth, low birth weight, cesarean delivery, and birth complications) and postnatal exposures (like early childhood illness or medication or breastfeeding) are discussed as being causative or associated with MIH. In any case, multifactorial pathogenesis with a possible genetic component seems likely [8–12].

In comparison to normal teeth, MIH-affected teeth show histologically less distinct prism sheaths and a lack of arrangement of the enamel crystals. The hypomineralized enamel shows lower mechanical properties, as hardness and modulus of elasticity were

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found to have lower values than those found in normal enamel [13–18]. MIH enamel shows increased amounts of proteins like serum albumin, type I collagen, ameloblastin, α1-antitrypsin, and antithrombin III, which were found to inhibit the growth of hydroxyapatite crystals and enzymatic activity during enamel maturation, resulting in an overall reduction of minerals in MIH enamel [19,20].

The management of MIH is challenging as the clinical appearance and individual need for treatment varies widely, with a broad spectrum of treatment modalities being available, ranging from prevention of enamel breakdown or caries, management of hypersensitivity or pain, restorative treatments, to extraction with or without subsequent orthodontic alignment of adjacent teeth [2–4]. The decision as to which of these options is suitable needs to be made individually considering the severity of the lesions, the symptomatology of the affected tooth as well as the patient's dental age and expectations [3]. Moreover, knowledge on the suitability of different treatments for specific situations as to their success (no need for re-intervention), survival (no need to extract MIH-affected molars), subjective evaluation (absence of postoperative mild or severe pain, aesthetics, and masticatory function) and cost-effectiveness is needed to make informed clinical decisions.

A number of reviews have reported on available treatment modalities; with one exception all these reviews have not been performed systematically [3]. A systematic review of treatment modalities in MIH-affected molars and incisors is needed to inform practitioners as to how well different treatments perform in different patients, and to guide future research in the direction of MIH treatment. We aimed to answer the following question: In children diagnosed with MIH, which treatments have been evaluated by clinical studies, and how did these treatments perform?

2. Methods

2.1. Eligibility criteria

This systematic review (registered at PROSPERO CRD42016039677) included clinical trials

- on human subjects having a minimum of one permanent first molar with MIH (with or without affection of one or more incisor) in need of any, i.e. preventive, restorative, endodontic, surgical and/or orthodontic, treatment. Note that the decision as to if a treatment was needed could have been made subjectively; we did not predefine criteria how such need was decided. Given the wide range of treatment modalities, we expected a range of lesion severities and symptomatologies to be included.
- reporting on minimum one such treatment, which means that studies could be retrospective or prospective, controlled trials or cohort studies.
- with a minimum sample size of 10 to exclude small case series, as any inference as to how well a treatment truly performs based on such small sample sizes is unlikely to be robust
- reporting on the "performance" of the provided treatment, as described below.

Consequently, case reports or small case series, studies describing a treatment method without reporting any results, review articles or non-clinical studies were excluded.

2.2. Outcomes

The primary outcome was the "success" of a treatment, i.e. the proportion of teeth and/or patients where the treatment did not need repeating or other re-interventions. Success captures a range of complications, like enamel breakdown, caries occurrence, restoration failure, pain needing endodontic treatment, or the proportion of cases requiring orthodontic alignment after extraction (i.e. without spontaneous alignment).

Preventive treatments, like fluoride varnishes, are oftentimes repeated in a planned manner without this being considered a "failure". Therefore, success was defined as the proportion of teeth or patients, which did not require further (restorative, endodontic, surgical) interventions for these treatments.

The secondary outcomes were

- adverse events (like allergies towards a used material)
- treatment costs or efforts (required time, materials)
- subjective evaluations by patients, parents, or dentists.

We have not specified upfront how outcomes needed to be reported (on binary, ordinal or continuous scale etc.).

2.3. Information sources and study selection

We searched Medline via PubMed, Embase via Ovid, Cochrane Central and Google Scholar. Moreover, opengrey.eu was searched to identify accepted, but not published studies. In addition, reference lists of identified full texts were screened and cross-referenced. We contacted study authors if required to obtain full texts. The search covered a period from January 1, 1980, to May 1, 2016. Neither authors nor journals were blinded to reviewers. No language restriction was set; studies in languages other than English or German were translated by native speakers.

2.4. Search strategy

The following search was adapted for each database:

((((((((((((((((((mottled enamel) OR non endemic mottling of enamel) OR internal enamel hypoplasia) OR cheese molars) OR non-fluoride enamel opacities) OR idiopathic enamel opacities) OR enamel hypomineralization) OR enamel hypomineralisation) OR hypomineralized molars) OR hypomineralized molars) OR molar incisor hypomineralization) OR molar incisor hypomineralisation) OR molar-incisor hypomineralization) OR molar-incisor hypomineralisation) OR molar-incisor-hypomineralization) OR molar-incisor-hypomineralisation) OR mih)) AND ((((((management) OR treatment) OR orthodontics) OR extraction) OR first permanent molar) OR clinical).

2.5. Selection process

Both authors (FS, KE) independently screened titles and then compared their findings. In the case of disagreement, titles were included to obtain full texts. Full texts were assessed independently after de-duplication. Studies were included after agreement with a consensus in cases of disagreement being reached through discussion.

2.6. Data collection process

A pilot-tested spreadsheet was used for data extraction, which was performed independently by both reviewers (FS, KE). No disagreements occurred.

2.7. Data items

The following items were collected: Author names, year of publication, sample size, sample characteristics, type of intervention, drop-out rate, results and risk of bias.