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Managing molars with severe molar-incisor hypomineralization: A cost-effectiveness analysis within German healthcare

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ABSTRACT

Objectives: Dentists have a range of options for managing molars with severe molar-incisor hypomineralization (MIH), each with different long-term implications. The cost-effectiveness of managing molars with severe MIH was assessed.

Methods: A mixed public-private-payer perspective within German healthcare was adopted. Individuals with one to four severely MIH-affected molars were followed over their lifetime. We compared: (1) removal of the tooth/teeth and orthodontic alignment of the second and third molars (Ex/Ortho); (2) restoration of the tooth using resin composite (Comp); (3) restoration using an indirect metal crown after temporizing it using a preformed metal crown (PMC/IR). The health outcome was tooth retention years. Transition probabilities were estimated based on the best available evidence. Cost calculations were based on German dental fee catalogues. Monte-Carlo microsimulations were performed for cost-effectiveness-analysis.

Results: If extraction was performed at the optimal age (9.5/11 years for maxillary/mandibular molars), Ex/Ortho was most cost-effective (67 years, 446–938 Euro). Comp (51 years, 1911 Euro) and PMC/IR were dominated (50 years, 2033 Euro). This cost-effectiveness ratio was also determined when > 1 molar was treated. If extraction was performed later, assuming no spontaneous alignment, Ex/Ortho was more costly than Comp, at least when only 1 molar was treated.

Conclusions: For molars with severe MIH, extraction at the optimal age and, if needed, orthodontic alignment can be cost-effective, especially when > 1 molar is affected. For single molars where the chance of spontaneous alignment is low, Comp might also be considered. These findings apply to German healthcare and within the limitations of this study only.

Clinical significance: When deciding how to manage molars with severe MIH, both tooth retention, with lower costs but higher needs for re-treatments, and tooth removal, with possible need for orthodontic alignment, can be considered. Considering cost-effectiveness, the latter may be preferable, especially if the age of extraction is chosen correctly, or several molars are affected.

1. Introduction

Qualitative, demarcated developmental hypomineralized defects of one or more permanent first molars, with or without signs of lesions on the incisors, are defined as molar-incisor hypomineralization (MIH) [1]. Given the relatively high prevalence of 2–40% [2] of MIH and the associated clinical symptoms (ranging from non-cavitated or cavitated structural defects to hypersensitivity or pain, or esthetic impairment), there is great need for effective management options for MIH [3].

A range of non-invasive, micro-invasive and invasive treatment options is theoretically available. The suitability of these, however, differs depending on the severity (mild to severe) and symptoms (with or without the association of hypersensitivity) of MIH. For severe cases (those with cavitated structural defects in the enamel) dentists can either (1) restore the defects directly (usually using resin composite), (2) restore them indirectly (for example using ceramic or metal restorations), or (3) remove the tooth, followed by spontaneous or orthodontic alignment of the adjacent teeth [4]. Spontaneous alignment has been found in up to 82% and 63% of the adjacent teeth in the maxilla and mandible, respectively, under certain conditions and appropriate extraction timing [5–8].

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Table 1
Parameters used for effectiveness estimation.

Health state	Reference	Transition probability per year	Triangular distribution	Allocation to	Allocation probability
Spontaneous alignment maxillary molar at age 9.5 years	Eichenberger et al. [4]	–	0.8;1.0;1.2	No orthodontic therapy Orthodontic therapy	0.82 0.18
Spontaneous alignment mandibular molar at age 11 years	Eichenberger et al. [4]	–	0.7;1.0;1.3	No orthodontic therapy Orthodontic therapy	0.63 0.37
Aligned second molar	Broadbent et al. [8]	0.011	0.1;1.0;3.0	Caries → composite	1.00
Composite on MIH molar	Elhennawy and Schwendicke [3]	$0.0436y^{-0.113}$	0.5;1.0;1.5	Repair Re-replacement RCT Extraction	0.42 0.43 0.08 0.07
Repaired composite	Kanzow et al. [27]	RR = 3.4 relative to newly placed composite	0.9;1.0;1.6	Replaced composite RCT Extraction	0.85 0.10 0.05
Replaced composite	Kanzow et al. [27]	RR = 1.4 relative to newly placed composite	0.7;1.0;1.7	Crown RCT Extraction	0.85 0.08 0.07
Preformed metal crown	Elhennawy and Schwendicke [3]	0.013	0.1;1.0;2.3	Crown or PMC RCT Extraction	0.85 0.08 0.07
Crown	Burke and Lucarotti [28]	0.076	0.7;1.0;1.7	Re-cementation RCT Re-new Extraction	0.25 0.25 0.13 0.12
RCT	Ricucci et al. [29]; Schwendicke and Stolpe [30]	$0.0232y^{-0.823}$	–	Non-surgical re-RCT Extraction	0.50 0.50
Non-surgical re-RCT	Ng et al. [31]	0.059	0.3;1.0;2.0	Surgical re-RCT Extraction	0.80 0.20
Surgical re-RCT	Torabinejad et al. [32]	0.080	0.5;1.0;2.0	Extraction	1.00
Implant loss	Jung et al. [33]	0.032	0.5;1.0;1.7	Renewal Removal	0.5 0.5
Implant crown failure or loss	Jung et al. [33]	0.047	0.6;1.0;1.8	Renewal Re-cementation	0.4 0.6

Each of these options has a number of advantages and disadvantages: (1) Resin composite restorations do not require substantial tooth hard tissue removal, but have a significantly lower survival probability in MIH than non-MIH molars [4]; (2) Indirect restorations usually require additional preparation (substance loss), but have high survival probabilities. They are also more expensive than resin composites, and are unsuitable soon after eruption, but years later (when the final occlusion has settled). Therefore, MIH molars, which are planned to receive indirect restorations usually require temporization, for example with preformed metal crowns (PMC). (3) Removing the teeth is the most invasive option, but may achieve the best long-term prognosis: MIH molars have significantly increased treatment needs and after repeated re-interventions, extraction may be required. In this case, spontaneous or orthodontic alignment of adjacent teeth might not be feasible any longer, with replacement of the tooth (via bridges or implant-retained crown) being necessary.

The early treatment decision made for a molar with severe MIH has long-term consequences both clinically and economically: As described, certain treatments (such as resin composites) are initially far less costly than others (such as indirect restorations or removal and orthodontic alignment). They might, however, require more follow-up treatments, and earlier tooth loss, which increases long-term costs. The present study aimed to assess the cost-effectiveness of resin composite, indirect restorations, and tooth extraction plus (if needed) orthodontic treatment for severe MIH molars.

2. Methods

2.1. Setting, perspective, population, horizon

This study adopted a mixed public-private-payer perspective in the context of the German healthcare system. We modelled a population of initially 6-year old male individuals with one, two, to four permanent severe MIH-affected molars with a vital pulp. Molars were assumed to require restorative or surgical/orthodontic treatment, and were followed over the patient's lifetime (TreeAge Pro 2013, TreeAge Software, Williamstown, MA, USA). Patient level costs were calculated, while effectiveness was calculated as mean value per molar (see below).

2.2. Comparators

Based on a recent systematic review, the study team, which involved preventive and restorative clinicians, orthodontists, and pediatric dentists, appraised the available options. These were different directly placed restorations, such as resin composite, amalgam, compomer, glass ionomer cement restorations or preformed metal crowns; different indirectly placed restorations, such as metal, ceramic or composite inlays/onlays/crowns; extraction and orthodontic alignment if needed [3]. It was decided to assess three different strategies, based on two key questions: (a) Which options are supported by the majority of data, where uncertainty in survival is low enough to yield estimates with certain robustness, and where new studies are unlikely to completely change that estimate?, and (b) Which options are representative for other options and could serve as indicator strategies (like resin composite, which – within the chosen setting – have similar costs to amalgam, compomer or preformed metal crowns), i.e. modelling further and similar options would have only limited information gain?

The three options we eventually chose were (1) the removal of the tooth and orthodontic alignment of the second and third molar (Ex/Ortho); (2) the restoration of the tooth using resin composite (Comp); (3) the restoration of the tooth using an indirect restoration,