

The Würzburg MIH concept: the MIH treatment need index (MIH TNI)

A new index to assess and plan treatment in patients with molar incisor hypomineralisation (MIH)

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Abstract

Aim This was to create a new easy-to-use index for the treatment of MIH.

Methods An international MIH working group developed a new MIH index as an epidemiological screening procedure for assessing MIH treatment needs (MIH-TNI), and also for the screening and monitoring of individuals by dental practitioners.

Results The MIH TNI assesses in particular the extent of the destruction of tooth structure in combination with any hypersensitivity occurring in MIH. The MIH-TNI is suggested as a basis for individual dental examinations covering all MIH typical problems or treatment planning. In addition, this index shall be the basis for decision-making in any MIH therapy studies already planned.

Conclusion After the validation of the MIH TNI it may be possible to create a standardised approach for dental treatment for MIH.

Keywords MIH · Molar-Incisor-Hypomineralisation · Odontogenic disorders · Enamel and dentine hypoplasia · Index

Introduction

The term Molar Incisor Hypomineralisation (MIH) describes a developmental, qualitative enamel defect caused by reduced mineralisation, inorganic enamel components which leads to enamel discolouration and fractures of the affected teeth (Weerheijm et al. 2003). Originally this clinical picture was defined as affecting the first permanent molars and incisors (Report FDI 1992; Jälevik 2010), but recently these defects have been described in all types of primary and permanent teeth (Steffen and van Waes 2011). Worldwide studies have reported MIH prevalence as ranging between 3 and 44% (Elfrink et al. 2015). Due to these differing results standardised studies with consistent and more detailed determination of the prevalence and the aetiology have been requested (Elfrink et al. 2015). Equally, large differences were found between the examination methods of these different studies and the descriptive indices used (Ogden et al. 2008). It was requested that at least 300 subjects should be included in studies on the prevalence of MIH and at least 1000 participants in MIH aetiology studies (Elfrink et al. 2015).

Focusing on the therapy of MIH, various problems dominate the approach. On the one hand, it is difficult to determine the exact extension of restorations in hypomineralised enamel. After therapy, large fractures on the margins of the restorations occur frequently. Furthermore, it is difficult to assess whether discoloured but not-yet damaged enamel will not fracture in the near future. For daily oral hygiene and for the treatment of MIH teeth, it is of great importance that many MIH teeth show more or less severe degrees of hypersensitivity which can lead to severe discomfort in intact or already damaged teeth representing a considerable risk for these teeth (Steffen and van Waes 2011). Published therapeutic recommendations are either

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anecdotal or are general and not patient-specific (Lygidakis et al. 2008). Studies with indices relating to treatment recommendations differentiate between mild, medium or severe MIH. The main consideration is thus the enamel-dentine defect and not the hypersensitivity.

An Australian working group (Oliver et al. 2014) was the first in 2014 to combine the defect size of individual teeth and the entire dentition with a treatment recommendation by introducing the molar hypomineralisation severity index (MHSI). Nevertheless, a distinction was only made between mild, medium and severe MIH cases.

There is still a missing connection between a standardised simple assessment criterion which represents defect size and hypersensitivity (Bekes and Hirsch 2013) in single teeth, and the whole individual's oral health together with a treatment recommendation. Such an index can then be used for epidemiological studies on data collection as well as for individual patients for the assessment of the condition and treatment planning.

MIH affected teeth have two main problems: reduced fracture resistance to a greater or lesser degree and sometimes considerable hypersensitivity. Both factors mainly influence the treatment planning.

Initial approach

During the spring meeting of the German Society of Paediatric Dentistry (DGKiZ) in Würzburg (Germany) in 2016, an international working group with representatives from universities in Germany, Austria and Switzerland met with the following goals:

1. Development of a MIH-Treatment Need Index (MIH-TNI) based on the Community Periodontal Index of Treatment Needs (CPITN) (Cutress et al. 1987) and the MIH treatment model “Don't Hesitate” from the University of Zürich (Steffen and van Waes 2011).
2. Development of a specific treatment plan based on the MIH-TNI.

The MIH-TNI should meet the following criteria:

- Detection of both the extent of the defect and the problem of hypersensitivity.
- Suitability for application and investigation on larger collectives as well as for an exact description of the individual.
- Usability for individual paediatric patients for treatment planning.

Following several standardized scientific studies, which are based on this index, it should be possible in the future to gain insights into the prevalence of MIH. As a result of

these studies, therapeutic recommendations with a scientific background could be given to practitioners.

Assessment of MIH

Initially, a literature search was carried out to identify the various relevant, currently existing assessment and classification procedures for MIH. The Metadatabase Pubmed by the U.S. National Library of Medicine and the Web of Science were used. Additional searches were conducted with Google.

The following examination and classification indices have been identified. They are described according to the year of their development and their publication:

- In an epidemiological study with a focus on caries detection, a working group lead by Wetzel (Fritsche et al. 1991; Wetzel and Reckel 1991) described hypoplasia on six-year molars for the first time in the German-speaking world, and subdivided them into severity grades A (or 1) to C (or 3). Severity A/1 describes mild opacity, severity B/2 comprises significant discoloration with low loss of substance and severity C/3 includes mineralisation disturbances with considerable defects. Hypersensitivities were not considered.
- Several working groups (Balmer et al. 2005; Jälevik et al. 2001) used the developmental defects of enamel index (DDE) of the FDI Working Group (Report FDI 1992) in studies on the prevalence of MIH: (A) clearly demarcated opacity, (B) diffuse opacity associated with hypoplasia. Hypersensitivities were also ignored.
- A Dutch working group lead by Jsulaityte et al. (2008) used an MIH classification in two studies with the same objective (1999 and 2003) according to the following characteristics: opacities, enamel destruction after eruption, atypical restoration and extraction due to MIH. Hypersensitivity was not assessed.

Ogden et al. (2008) investigated MIH seemingly affected teeth damaged in archaeological findings and described the proportion of destroyed surfaces. They subdivided their material into the categories “mild” (<30% destroyed area), “moderate” (30–50%) and “severe” (>50%).

- A Swedish study conducted by Poulsen (Soviero et al. 2009) in 2009 also classified MIH defects as mild, moderate or severe in Brazilian children. Over 25% enamel disintegration led to the distinction of moderate to heavy. Hypersensitivities were mentioned only marginally.
- The recommendations by the European Academy of Paediatric Dentistry (EAPD) regarding “Best clinical

practice ... dealing with children ... with MIH” by Lygidakis et al. (2010) reflected the results of the EAPD Interim Seminar 2008 held in Helsinki and the classifications proposed by Lygidakis et al. (2008). The EAPD recommended a distinction into “mild” and “severe”, whereby the condition “severe” can be subjectively linearly increased according to its severity. Hypersensitivities were mentioned but not included in the therapeutic recommendations.

- A new MIH-severity index (MHSI) was introduced by an Australian working group by Oliver et al. (2014). That index proposed to not only to describe MIH but also of Molar Hypomineralisation (MH) due to the observation of generalised hypomineralisations in the primary and permanent dentitions. This was achieved due to the fact that in the molar region enamel disintegrations and hypersensitivities occur, while in the region of the incisors these are mostly only occur as opacities. Hypersensitivity, discolouration, atypical restoration and disintegration were joined together in order to be able to divide them mainly into three different categories. The MHSI differentiates a value scale for the whole dentition (values 1–52) and also for individual affected teeth (values 1–13). Different therapeutic recommendations are given for the categories mild, moderate and severe. For example, brown opacities, especially on the cusps of the molars, are more problematic than white discolourations on the smooth surfaces.

The fact that a pronounced hypersensitivity can significantly influence the eating habits, oral hygiene and the patient cooperation in possible restorations has not yet been included in any assessment scheme. The aim of the Würzburg Working Group was therefore to develop a rating scheme and an index with which can be assessed for both population groups as well as individuals. Also, the essential parameters of the MIH—the opacity, the enamel fractures and the hypersensitivity—are taken into consideration.

Different indices have been refined in recent years and was a focus on opacities and the extent of the damage. Later, there were attempts to include hypersensitivity as an MIH-relevant parameter. The fact that hypersensitivity can significantly influence the eating habits, oral hygiene and the patient cooperation in required restoration procedures, has not yet been included in any assessment scheme.

The aim of the Würzburg MIH work group was therefore to develop an index that offers the possibility to assess populations and individuals. Essential parameters of MIH—opacity, substance loss and hypersensitivity—should be considered.

The MIH-TNI

Evaluation criteria

The following evaluation criteria apply to primary and permanent teeth. As guidelines for the decision “MIH Yes” or “MIH No” serve as the criteria of the EAPD which have now been supplemented by additional features. Having made the decision of MIH occurring or not all patients with other developmental defects of enamel can be eliminated.

“Yes”-decisions are made if any of the following characteristics are apparent:

- affected teeth show a clearly defined opacity at the occlusal and buccal surfaces of a tooth,
- defects vary in shape, size and pattern,
- white, cream-coloured or yellow–brown colour deviations are recognizable,
- defects vary in size in a variable manner (caution: defects with a diameter/expansion <1 mm are not recorded),
- teeth with hypersensitivity are present,
- teeth have an atypical restoration (Fig. 1),
- permanent teeth for (suspected) MIH reasons are missing (extractions),
- combinations of the above characteristics are present.

If an “MIH Yes” decision is taken, a further grading can be made by subdividing the index into 1–4.

Grading/classification of the MIH-TNI

This grading is based on the two clinically most important guiding symptoms: hypersensitivity and destruction (disintegration). The index values 1–4 are shown in Table 1.

The findings are collected visually with mirror, tactile with a probe and on drying with an air syringe.



Fig. 1 MIH molar with severe substance defects and showing an atypical restoration due to hypersensitivity

Application of the MIH-TNI

The MIH-TNI can be used for individual MIH diagnosis and treatment planning. It is equally suitable for epidemiological studies. There are six measurements for index reference. These measurements (sextants) are:

1. Sextant: Maxilla right distally to/with 14 (54).
2. Sextant: Maxilla front with 13–23 (53–63).
3. Sextant: Maxilla left distally to/with 24 (54).

Table 1 MIH-TNI

Index	Definition
Index 0	No MIH, clinically free of MIH
Index 1	MIH without hypersensitivity, without defect
Index 2	MIH without hypersensitivity, with defect
2a	<1/3 defect extension
2b	>1/3 < 2/3 defect extension
2c	>2/3 defect extension or/and defect close to the pulp or extraction or atypical restoration
Index 3	MIH with hypersensitivity, without defect
Index 4	MIH with hypersensitivity, with defect
4a	<1/3 defect extension
4b	>1/3 < 2/3 defect extension
4c	>2/3 defect extension or/and defect close to the pulp or extraction or atypical restoration

Maxillary right	Maxillary front	Maxillary left
Mandibular right	Mandibular front	Mandibular left

Fig. 2 Measurement in sextants

Fig. 3 Assessment of the MIH-Treatment need index in epidemiological studies

MIH-TNI		

4. Sextant: Mandible left distally to/with 34 (74).
5. Sextant: Mandible front with 33–43 (73–83).
6. Sextant: Mandible right distally to/with 44 (84).

Since MIH infection is already described in all occurring permanent and primary teeth in the literature, the distinction between the permanent and primary teeth is no longer made, and it is also no longer measured only on the first permanent molars and the incisors but on all existing teeth (Table 1).

Note

- Measurements should be carried out in a clockwise direction, starting maxillary right as the first quadrant.
- The highest value is recorded for each sextant.
- Values are noted when viewing the patient from the front (Fig. 2).
- Examination of the teeth should be carried out with good lighting, drying with an air syringe and by trained examiners.

Measurements taken in every sextant lead to a Yes or No decision.

- “No-decision”: Status/Index 0: no signs of MIH are found, clinically healthy.
- “Yes-decision”: Status/Index 1 or higher: signs of MIH can be found.

There are two possibilities of applications:

1. In epidemiological studies on the sextants defined above and the using the sextant recording diagram (Fig. 3).
2. For an individual risk assessment on each tooth affected by MIH (Fig. 4).

Implementation of the MIH-TNI

The next steps should be

- developing a training and calibration programme for examiners,
- validation and verification of applicability in epidemiological studies and individual treatment planning,

Description MIH	Affected Teeth	Intervention
MIH Index I		
Without hypersensitivity, without defect		
MIH Index II a, b or c Without hypersensitivity, with defect		
MIH Index III		
With hypersensitivity, without defect		
MIH Index IV a, b or c With hypersensitivity, with defect		

Fig. 4 Reporting form and individual risk assessment in patients

Fig. 5 An example of index MIH-TNI 1 a molar and the incisors



Fig. 6 Intra-oral photograph showing index MIH-TNI 2a MIH Molar with defect smaller than 1/3 of the surface and without hypersensitivity

- development of a therapy approach based on the MIH-TNI.

In everyday clinical work, MIH shows various characteristics. Many teeth or only one tooth may be affected. The defects can be moderate, substantial or very severe. In addition, the occurrence of hypersensitivity is highly variable. This typically occurs frequently during the beginnings of a change from primary to permanent dentitions and eruption of the first permanent molars. The MIH-TNI may allow a consistent classification of the different MIH conditions in studies and individual treatment planning. Examples of diagnoses with MIH-TNI are shown in the figures (Figs. 5, 6, 7, 8, 9, 10, 11, 12).

With the MIH-TNI, it may be possible to obtain reproducible findings for each individually affected patient concerning his problems and specific clinical picture. Based on this index, the aim of this working group was to



Fig. 7 Intra-oral photograph showing index MIH-TNI 2b MIH molar showing a defect of ca. 2/3 of the surface without hypersensitivity



Fig. 8 Photograph showing typical index MIH-TNI 2c MIH molar with a defect of more than 2/3 of the surface showing no hypersensitivity



Fig. 9 Photograph showing an example of index MIH-TNI 3 MIH molar without a surface defect but with hypersensitivity. Leavings of plaque are visible



Fig. 11 Photograph showing index MIH-TNI 4b MIH molar with a defect up to 2/3 of the surface showing hypersensitivity



Fig. 10 Photograph showing index MIH-TNI 4a MIH molar with a defect size less than 1/3 of the surface, also showing hypersensitivity



Fig. 12 Photograph showing index MIH-TNI 4c MIH molar with a defect size bigger than 2/3 of the surface and with hypersensitivity

develop a therapy concept which takes into account all possible findings and complications. This should allow all clinicians to treat all problems as promptly as possible in a simple form and with clearly described therapy options. Treatment plans should include prevention, regeneration, immediate treatment and long-term planning.

As a further major option, the newly developed MIH-TNI can be used to investigate larger populations in a standardized way and to use standardized therapy procedures in MIH patients based on these studies.

Conclusion

The treatment of MIH in children plays an increasingly important role. The extent of hypomineralisations and the resulting problems can vary widely. It is important to record patients with MIH at an early stage to provide comprehensive care and to integrate them into a comprehensive recall programme. This increases the chances to achieve a satisfactory rehabilitation in both functional and aesthetic terms. With the MIH-TNI, this should be possible

to study the condition in larger populations of children as well as for difficult individual cases.

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Compliance with ethical standards

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