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Distribution and characteristics of molar-incisor hypomineralization

Rasprostranjenost i karakteristike hipomineralizacije na kutnjacima i sekutićima

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Abstract

Background/Aim. Developmental disorders of teeth are the problems that are becoming more present in pediatric dentistry, especially on first permanent molars and incisors. Molar Incisor Hypomineralization (MIH) is proposed term for this phenomenon. The aim of this study was to establish the MIH prevalence in children living in the Foča municipality (Bosnia and Herzegovina) as well as to assess characteristics and expression of hypomineralization within the tested population. **Methods.** A total of 141 children from the Foča municipality, 8 years of age, were included in this study. Criteria according to Weerhejm have been used for diagnosis of hypomineralization: demarcated opacity (DO), post-eruptive breakdown (PEB), atypical restoration (AR), extracted molars due to MIH (E-MIH) and unerupted tooth (UT). Level and the prominence of color changes have been determined for patients with DO, PEB and AR. **Results.** MIH in this area was present in 12.8% of children. The prevalence of MIH changes expressed in percentages was as follows: DO was at 9.2%, PEB in 3.5%, AR in 5.6%, while E-MIH was 5.6%. A total of 9.9% of the examinees had mild, 5.6% moderate, and 7.8% severe form of MIH. White form of MIH defects was found in 9.9% of the examinees, white-yellow one in 5.6% and yellow-brown color in 3.5% of the examined children. These changes were more often present in the lower jaw (60.3%). In total, 6.4% of children had these changes present only on molars, while 6.4% of them both on molars and incisors simultaneously. **Conclusion.** A total of 12.8% of the examinees with MIH is not to be disregarded. With timely diagnosis, prevention and therapy complications could be avoided or mitigated.

Key words:
tooth demineralization; dentition, permanent, child; bosnia-herzegovina; molar; prevalence.

Apstrakt

Uvod/Cilj. Razvojni poremećaji zuba sve su prisutniji problem u dječjoj stomatologiji, posebno na prvim stalnim kutnjacima i sekutićima. Za ovu pojavu, predložen je termin molar-incizor hipomineralizacija (MIH). Cilj istraživanja bio je da se utvrdi stepen rasprostranjenosti MIH kod djece iz Foče, te procijene karakteristike i stepen izraženosti hipomineralizacije kod ispitivane populacije. **Metode.** Ispitivanjem je obuhvaćeno 141 dijete iz opštine Foča (Bosna i Hercegovina), starosti osam godina. Za dijagnozu oboljenja korišteni su kriterijumi po Weerhejm-u: ograničena zamućenost gleđi (OZG), poseruptivni prekid gleđi (PPG), atipične restauracije (AR), vađenje kutnjaka zbog MIH (E-MIH), i retencija zuba (RZ). Ispitanicima kojima je evidentirana OZG, PPG i AR određen je stepen i boja izraženosti promjene. **Rezultati.** Molarna i incizorna hipomineralizacija na ovom području iznosila je 12,8%. Distribucija MIH promjena po stepenima bila je sledeća: OZG iznosila je 9,2 %, PPG pronađen je kod 3,5 % ispitanika, AR pronađene su kod 5,6 % ispitanika, dok je E-MIH utvrđena kod 5,6% ispitivane djece. Blagu formu imalo je 9,9% ispitanika, umjerenu 5,6% ispitanika, a tešku 7,8%. Bijela boja MIH defekata konstatovana je kod 9,9% ispitanika, bjeložuta kod 5,6%, a žutobraon kod 3,5% djece. Rezultati pokazuju da je donji desni prvi stalni kutnjak najčešće izvađeni zub zbog MIH, kao i da su ove promjene prisutnije u donjoj vilici (60,3%). Ukupno 6,4% djece imalo je promjene samo na kutnjacima, a 6,4% djece na kutnjacima i sekutićima istovremeno. **Zaključak.** Procenat od 12,8% ispitanika sa MIH promjenama nije zanemarljiv. Ranom dijagnozom, te blagovremenom prevencijom i terapijom, znatno se mogu spriječiti i ublažiti komplikacije.

Ključne reči:
zub, demineralizacija; denticija, stalna; deca; bosna i hercegovina; molari; prevalenca.

Introduction

In addition to dental caries and its complications, developmental disorders of the teeth are becoming increasingly common problem in dentistry. Tooth decay is the most widespread disease of the modern era, but in many developed countries where the level of health education is at an enviable level, significant results were achieved with prevention

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of caries and its complications. The obvious decline in caries prevalence was registered in Switzerland in early sixties, in the Scandinavian countries in the late sixties, and in Denmark in late seventies [1]. Another problem was noted in these countries regarding the disease of hard dental tissue, and that is a growing percentage of people with the onset of tooth enamel mineralization disorders, especially on the first permanent molars and incisors.

In Denmark, for example hypomineralized enamel defects in first permanent molars are more frequent than caries on the occlusal surfaces of these teeth [2]. Weerheijm et al. [3] were the first to observe and describe clinical picture of idiopathic enamel hypomineralization. They also pointed to the significance and inconvenience caused by these teeth. The authors have proposed the term Molar Incisor Hypomineralization (MIH) for this phenomenon, and defined it as systemic origin hypomineralization of one or more first permanent molars, often associated with changes in the maxillary and mandibular incisors. Literature data indicate a different distribution of this phenomenon in the world, from 2.9% to 25% [4–9], suggesting a different, yet undetermined etiology, and uneven methodology for estimation of these defects.

Clinically, MIH is presented as a limited demarcated opacity (enamel opacity) of irregular shape, different color and abnormal translucency. Enamel opacities can be soft with frequently observed enamel discontinuity. These changes are especially expressed in the first permanent molars immediately after the eruption [10]. Irregular patches of different colors are usually observed at central incisors labial surfaces, and they are rarely accompanied by enamel discontinuity [11]. Common for the incisors and molars (affected with MIH), in most of the cases, is sensitivity to thermal, chemical and mechanical stimuli [3]. Children with these changes tend to avoid washing teeth due to painful sensations they feel. This creates a greater amount of dental plaque, which is followed by rapid progression of carious lesions that lead to the destruction of the crown and eventually to tooth loss [12].

In children with MIH, dental treatment need is multiply increased, considering the fact that these teeth, especially molars, depending on the degree of hypomineralization are brittle, fragile and easily susceptible to caries [13, 14]. Although numerous studies have been conducted on caries prevalence in children, MIH was not monitored and its distribution was not defined in this area. MIH patients care requires teamwork and individual approach to each patient as well as well-designed plan of preventive and therapeutic measures.

The aim of this study was to determine the prevalence of molar incisor hypomineralization in children living in the Foča municipality, Bosnia and Herzegovina as well as to assess the characteristics and severity of hypomineralization in studied population.

Methods

In accordance with the objectives set, observational, descriptive and cross-section studies were undertaken. This was a retrospective study. There are two primary schools attended by about 2,000 students in Foča municipality. This survey is scheduled to include all children aged 8 years. There were a total of 147 such children, in 2005/06 school year. This age was chosen because the first permanent molars and central incisors relatively soon erupted, caries prevalence is still low, therefore ability of carious lesions to mask hypomineralization is reduced. Prior to examinations the parents were informed in writing of research purpose and methodology to be applied. The parents gave written consent for children participation in the study. There were no written consents for 6 children, so they were not included in the study.

Dental mirror, probe and common lighting were used for examinations of children. Probes were applied only as needed in order to remove dental plaque. All changes found were photographed with a digital still camera (Canon A 520). Examinations of children in urban schools took place in the school dental clinic, while the children of suburban schools were inspected in the brightest classroom. The study was approved by the Ethics Committee of the Medical Faculty in Foča and was conducted according to principles of the Helsinki Declaration.

Criteria used in this study and commonly used in the literature, are those proposed by Weerhejim et al. [15]. These are: demarcated opacity (DO); post-eruptive enamel breakdown; (PEB); atypical-restoration (AR); extracted molar due to MIH (E-MIH); unerupted teeth (UT).

Severity and color of changes were determined to patients with DO, PEB and AR. There are 3 degrees of severity as follows: mild form, moderate form and severe form. Mild form of tooth mineralization disorder is characterized by tooth enamel color changes (white, yellow or brown). Moderate form is characterized by discoloration and minimal loss of tooth substances without the need for restoration. Damaged enamel and dentin loss that require restoration are marked as a severe form. In the case when there is more than one defect on the tooth, toughest change was recorded as valid. Teeth with more than half of the crown arisen were included in the study while tooth lesion smaller than 1 mm were not included in the study.

Color of hypomineralized changes were characterized as: white, white-yellow and yellow-brown. Color of hypomineralized changes can be masked by dental fluorosis, and it is important to note the amount of fluoride in drinking water in the area where the children are grown. There are two water sources in Foča that supply households. One source has 0.00019 ppmF and the second 0.0025 ppmF, which means extremely low concentrations of fluoride in drinking water.

Reliability of the researchers for this type of research (extra-intra-examiners reliability) was performed in 10% of the planned sample (10% of respondents, 14 children, were examined twice with a minimum interval of 4 hours between hits) and Kappa value obtained in this way indicates the reliability of examiners (Kappa = 0.85). SPSS 11.0 was program used for data analyzing.

Results

The study included 141 subjects, with approximately the same percentage of boys (50.4%) and girls (49.6%). All

hypomineralized changes of teeth were observed in 18.4% of the children. The mentioned changes were slightly more represented in the group of boys (21.1%) compared to the group of girls (15.7%). Data analysis showed that the difference was not statistically significant ($\chi^2 = 0.687$; $p > 0.05$). Hypomineralized changes were more common in children from the urban area (20.4%), compared to children who were from suburban municipalities (13.2%), but data analysis did not find a statistically significant difference between these two groups ($\chi^2 = 0.965$; $p > 0.05$). However, hypomineralized changes that affect only the incisors without affecting the first permanent molars can be caused by other disorders, therefore they should not be counted as real MIH changes.

According to the results of this study, genuine MIH was present in 12.8% of the studied children in this area. MIH was found in 14.0% of the boys and 11.4% girls. Out of the total percentage of children with MIH defects 10.93% of the children had changes in two teeth, 39.07%, in three teeth, 39.07%, in four teeth and 10.93% in five teeth (Figure 1).

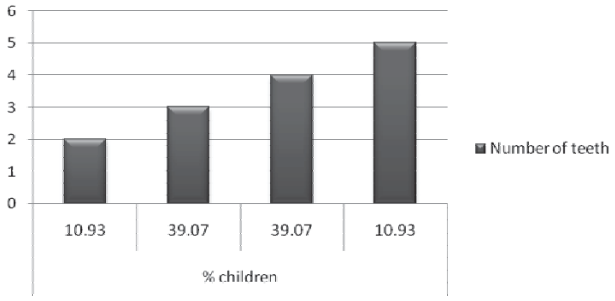

Fig. 1 – Molar-incisor hypomineralization (MIH). Prevalence according to the number of affected teeth.
E-MIH – extracted molars due to MIH

The prevalence of MIH changes according to the levels was as follows: demarcated opacity (DO) was present in 9.2%, post-eruptive breakdown (PEB) 3.5% of patients, atypical restorations (AR) were found in 5.6% of respondents, extraction of teeth due to hypomineralization (E-MIH) was found in 5.6% of children or 19.0% of the total number of MIH teeth and they were all molars (Table 1). Teeth that had not erupted due to MIH were not registered in this study. The obtained results indicate that demarcated opacity is the most common one. Molars were the most affected by all changes. Changes in molars regarding PEB were more common, as confirmed by the statistical significance ($\chi^2 = 6.414$; $p < 0.05$). The study found a high statistical difference when it comes to AR ($\chi^2 = 16.414$; $p < 0.01$) and E-MIH ($\chi^2 = 14.204$; $p < 0.01$) between the observed types of teeth. It should be, particularly noted, that relatively high percentage of teeth extracted due to MIH was found.

The mild form of hypomineralized change was the most common. It was found in 9.9% of respondents, or 52.4% of teeth with MIH. Moderate form of hypomineralized changes was found in 5.6% of respondents what was confirmed by significant statistical difference ($\chi^2 = 6.567$; $p < 0.05$). The severe form of MIH had 7.8% of the respondents, and all the changes were in molars ($\chi^2 = 12.654$; $p < 0.01$). If subjects with extracted teeth due to MIH were considered as severe form (MIH signs present on the other teeth), it could be noted that eleven children had a severe form of expression. Out of 16 totally affected teeth, four teeth were still present in the mouths of patients, and 12 teeth had already been removed (Table 2).

White color of hypomineralized changes was the most common. It was found in 9.9% of respondents. Out of 51 teeth with MIH (extracted teeth were not included in this analysis), the white color was present in 56.8% of teeth, mainly in molars, but there was no statistically significant difference ($\chi^2 = 0.471$; $p > 0.05$). White-yellow color was seen in 5.6% and yellow brown in hypomineralized changes 3.5% of the respondents. All these changes were more present in the molars, which is a highly statistically significant difference ($\chi^2 = 8.931$; $p < 0.01$ and $\chi^2 = 12.820$; $p < 0.01$) (Table 3).

Data analysis showed that the most frequently affected molar by MIH changes is the lower left first permanent molar – 36 (26.9%). When it comes to the incisors, most frequently affected by MIH changes, is the lower right central incisor – 41 (6.3%). The central incisors in the upper jaw

Table 1

Prevalence of molar-incisor hypomineralization (MIH) criteria

MIH criteria	Children (%)	Teeth with MIH (%)	Incisives (%)	Molars (%)
Demarcated opacity	9.2	44.4	46.4	53.6
Post-eruptive enamel breakdown	3.5	12.7	37.5	62.5*
Atypical-restoration	5.6	23.8	0.0	100†
Extracted molar due to MIH	5.6	19.0	0.0	100 †
Unerupted teeth	0.0	0.0	0.0	0.0

***Statistically significant difference ($p < 0.05$); †Highly statistically significant difference ($p < 0.01$).**

Table 2

Prevalence of molar incisor hypomineralization (MIH) expression

MIH expression level	Children n (%)	Present teeth with MIH n (%)	Incisives n (%)	Molars n (%)
Mild form	14 (9.9)	33 (52.4)	13 (39.4)	20 (60.6)
Moderate form	8 (5.6)	14 (22.2)	3 (21.4)	11 (78.6)*
Severe form	3 (2.1)	4 (6.3)	0 (0)	4 (100)
(present + extracted teeth)	3 + 8 = 11 (7.8)	4 + 12 = 16 (25.4)	0 (0)	16 (100)†

***Statistically significant difference ($p < 0.05$); †Highly statistically significant difference ($p < 0.01$).**

Table 3

Prevalence of colour in molar-incisor hypomineralization (MIH) changes

Colour of MIH changes	Examined children (%)	Present teeth with MIH (%)	Incisives (%)	Molars (%)
White	19.9	56.8	48.3	51.7
White-yellow	5.6	29.4	13.3	86.7*
Yellow-brown	3.5	13.7	0.0	100*

***Highly statistically significant difference ($p < 0.01$).**

were equally affected by the aforementioned changes. In this study, the changes mentioned before were not observed in the left lateral incisors (22, 32). The results show that the lower right first permanent molar (46) is the most frequent tooth extracted due to MIH, and that these changes were more present in the lower jaw (60.3%). If we analyze side of the jaw, MIH was more present on the right (52.37%), compared to the left side of the jaw – 47.63% (Figure 2).

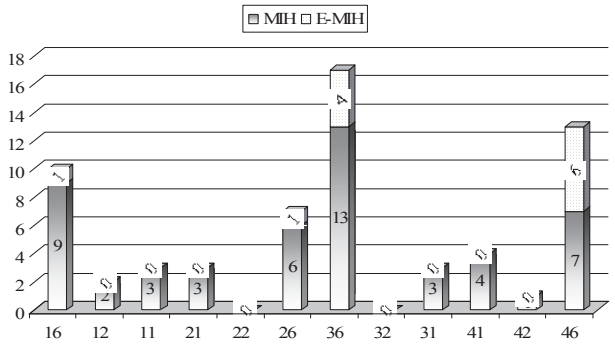

Fig. 2 - Teeth with molar-incisor hypomineralization (MIH) changes.

E-MIH – extracted molars due to MIH

Discussion

Over the recent years the literature often describes hypomineralization in permanent first molars and incisors as a clinical problem, in the same time indicating the necessity of conducting studies on the prevalence of these in various countries [5, 7, 10, 12, 16].

Hypomineralized changes can affect all the teeth in each dentition. This study examined the prevalence of hypomineralization in permanent first molars and incisors. A total of 6.4% of the children had changes in only the molars and 6.4% of the children in both molars and incisors, respectively. Statistical analysis showed no significant differences in MIH incidence for children of different gender, which is consistent with all studies on this issue [6, 7].

A study conducted in Italy (Lissone), also on eight year olds, showed the approximate results (13.7%) [7]. In Turkey, 14.8% of MIH changes were registered in the test group of children aged 7–12 years [17]. A significantly higher percentage of MIH was found in Finland in 2001, 19.3% [18]. In Sweden in 2001, a study performed in children aged 7–8 years, showed the prevalence of MIH of 18.4% [6]. More than 5,000 children, aged 7 years, were examined in Denmark in 2003, and the percentage of MIH was in the range of 15–25% [10]. A slightly lower percentage of MIH, compared to our results, was found in the Netherlands [19] in 2001, and Lithuania in 2007 9.7% [20]. Even smaller values (6%) were recorded in Greece in 2006. [21]. Two separate studies were conducted in Germany, in Dresden in 2003 [5] and in Giessen in 2006 [4], in different population groups, and similar percentages of MIH were registered. In Dresden MIH was 5.6% for the ages 10–17 years, in Giessen 5.9% in children from 6–12 years. A study conducted in Libya in 2006 in children between 7–9 years, found a significantly lower percentage of MIH (2.9%) [9].

The analysis of these epidemiological studies can lead to two conclusions: firstly, the percentage of MIH is not negligible although not all studies used the same criteria and, secondly, data from other areas of Europe and the world are missing in order to obtain a clearer picture and eventually discover a possible etiologic factor.

A review of the literature show that there is little data on individual MIH criteria representation. In a study conducted in Lithuania, limited representation was present in 54.8% of respondents with MIH changes [20]. Generally, the prevalence of individual criteria is difficult to compare because, despite the fact that they are clearly determined, detailed criteria are not precisely defined. One of the first concerns is the size of the lesion (demarcated opacity). Therefore, all the defects larger than 1 mm in diameter, were included in the study. Some studies have included only those defects that are larger than 2 mm [6, 7, 16, 18].

Analyzing the previous studies, we can conclude that the size of the lesions itself is not crucial because "small" lesions are usually seen only on incisors. Because incisors that are not followed by changes in molars at the same time are not included in MIH, not altering the end result. It is important to note that in many analyzes the color of a change is more important than the size itself. The white color and all its nuances can be differently noticeable on teeth. Undoubtedly, the chalky-white or yellow brown blur, on the tooth is clearly observed, although only 1mm sized [21].

Post-eruptive enamel breakdown was found in 12.7% of teeth. In a study conducted in Lithuania in 2007 [20], post-eruptive enamel breakdown was present in 28.2% of respondents with MIH. There is no information about what teeth were affected by post-eruptive enamel breakdown. Atypical restoration was found in 23.8% of MIH teeth, all of which were molars. In a study from Lithuania, atypical restorations were in 16.9% MIH patients. Teeth extracted due to MIH were all molars (19.0%). Having in mind that patients are 8 years old and the fact how important the first permanent molars are and that they have erupted quite recently percentage of extracted teeth was really great. In a study from Lithuania there were no teeth extracted due to MIH [20]. No erupted teeth due to hypomineralized changes were found in this research. This data is in agreement with the most of studies on MIH [5, 7, 16].

Mild form of hypomineralized changes is the most common in this study and is 52.4% of teeth with MIH. Compared to all MIH studies, we confirmed that a mild form prevailed. Moderate form of hypomineralized changes was found in 22.2% of teeth with MIH. The highest percentage was represented at the molars (78.6%). In the Italian study [7] no patients with moderate form of MIH changes were found. In Germany, Preusser et al. [4], found moderate forms in 25.4% of teeth with MIH present, while Dietrich et al. [5] found a smaller percentage of 6.1%. However, it is difficult to make comparisons when it comes to expression form of MIH changes, because only a small number of studies analyzed and shared the defects as mild, moderate and severe forms.

Severe form was found in 6.3% of teeth, or with extracted teeth counted a total of 7.8% of the respondents (what is 25.4% of teeth affected by MIH changes). Severe form was not found in the incisors of children examined. A similar percentage was found in a study from 2001 in Sweden, where the presence of severe forms was found in 6.4% of respondents [6], while a much smaller percentage was found in the group of children living in the Italian city Lissone (0.4%) [7]. Higher values were found in Finland [18] where 8.4% of respondents had the mentioned changes. A smaller percentage of severe form, on teeth with the mentioned changes, was established in Germany in 2003 (9.4%) [5] and 2006 (7.4%) [4]. It can be concluded, by analyzing these studies, that a relatively high proportion of severe form categorizes MIH as an important problem in pediatric dentistry. The authors did not specifically describe the color of hypomineralized changes in literature review.

MIH changes were more present in the lower (60.3%) compared to the upper jaw (39.7%). The first permanent molars in the lower jaw (36 and 46) are teeth with the most commonly diagnosed MIH changes. These results are in agreement with the results obtained by Kalderara et al. [7]. As for the incisors, in this study, MIH is equally present in the upper and lower jaw. Literature data indicate that changes are more present in the maxillary incisors [5, 6, 8].

Conclusion

Today, molar-incisor hypomineralization presents a problem in pediatric dentistry to children, parents and to dentists, as well, because of hypersensitivity that these patients experience, minor or major esthetic problems, the rapid occurrence of caries and its complications. Besides, etiology is still unknown. Early diagnosis and timely prevention and treatment can significantly reduce and prevent complications. These patients require a multidisciplinary approach and close cooperation between pediatric dentists, orthodontists, parents and patients themselves.

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