ACTA
STOMATOLOGICA
CROATICA
www.ascro.hr

Acta stomatol Croat. 2013;47(4):297-305.
IZVORNI ZNANSTVENI RAD
ORIGINAL SCIENTIFIC PAPER

Basak Durmus, Zerrin Abbasoglu, Sertac Peker, Betul Kargul

Mogući medicinski etiološki čimbenici i značajke molarno incizivne hipomineralizacije u skupini turske djece

Possible Medical Aetiological Factors and Characteristics of Molar Incisor Hypomineralisation in a Group of Turkish Children

Zavod za dječju stomatologiju, Stomatološki fakultet Sveučilišta Marmara, Turska
Department of Pediatric Dentistry, Marmara University Dentistry Faculty, Turkey

Sažetak

Svrha: Željele su se odrediti kliničke značajke i mogući medicinski uzroci molarno incizivne hipominerelizacije (MIH-a) u skupini turske djece. **Materijali i metode:** U ispitivanju je sudjelovalo 228 djece u dobi od 7 do 14 godina. Svi su pregledani na Odjelu za dječju dentalnu medicinu Stomatološkog fakulteta Sveučilišta Marmara u Istambulu. Prenatalni i postnatalni podatci prikupljeni su popunjavanjem upitnika. **Rezultati:** MIH je pronađen kod 54 (24 %) djeteta, a 41 (76 %) imalo je samo ograničena područja opaciteta (1. stupanj). Kod osam (15%) djevojčica i dječaka bile su obavljene atipične restauracije (2. stupanj), a barem jedno posteruptivno ljuštenje (3. stupanj) uočeno je kod njih pet (9 %). MIH je svima uglavnom zahvaćao kutnjake (55 %), a ne sjekutiće (45 %; p<0,001). U skupini s MIH-om bili su česti prenatalni bronhitis i hipertenzija. Nije bilo veće razlike u medicinskoj anamnezi do dobi od tri godine između skupine s MIH-om i skupine bez njega, osim duljeg uzimanja lijekova i astme u skupini s molarno incizalnom hipomineralizacijom (p<0,05). **Zaključak:** Premda etiologija MIH-a ostaje nejasna, čest je kod djece koja neprekidno uzimaju lijekove i oboljela su od astme u prve tri godine života.

Zaprimljen: 21. listopada 2013.
Prihvaćen: 1. prosinca 2013.

Adresa za dopisivanje
Betul Kargul
University Marmar
Faculty of Dentistry
Department of Pediatric Dentistry
Buyukciftlik Sok. No: 6
Nisantasi, Istanbul, Turkey.
Tel: +90 212 231 91 20
bkargul@marmara.edu.tr

Ključne riječi
zub, demineralizacija; kutnjak; sjekutić

Uvod

Prvi trajni kutnjak (FPM-s) s idiopatskom caklinskom hipomineralizacijom prvi je put opisan 1970-ih godina u Švedskoj. Autori su se za to stanje koristili sljedećim nazivima: *hipomneralizirani trajni prvi kutnjaci*, *idiopatska caklinska hipomineralizacija*, *nefluoridna hipomineralizacija* i *sirasti kutnjaci* (1,2,3). Caklinska hipoplazija (EH) može uključivati kvantitativne defekte u caklini zbog poremećaja ameloblasta tijekom stvaranja matriksa (4,5,6) i/ili kvalitativne defekte potaknute poremećajem u početnoj mineralizaciji i/ili sazrijevanju cakline (4,5). Pojam *molarna incizalna hipomineralizacija* (MIH) prihvaćen je na sastanku Europske akademije dječje dentalne medicine za određivanje kvalitativnih defekata cakline koji pogađaju jedan od četiriju prvih trajnih kutnjaka, a slični se defekti pojavljuju i na trajnim sjekutićima i očnjacima (7). Defekti klinički izgledaju kao opakne lezije s rasponom boje od bijele do žute ili smeđe i oštrim rubom između pogođene zdrave cakline (5). Posteruptivno ljuštenje cakline može se pojaviti brzo zbog sila žvakanja, što rezultira atipičnim kavitetima ili čak potpunom distorzijom krune te zahtijeva opsežne restorativne zahvate (8,9).

Etiologija MIH-a ostaje nejasna, ali mogući čimbenici su medicinski problemi tijekom trudnoće, prijevremeni poro-

Introduction

First permanent molar (FPMs) with idiopathic enamel hypomineralisation were recognised in Sweden for the first time in the 1970s. Authors have used various terms to refer to this condition, including 'hypomineralised permanent first molars', 'idiopathic enamel hypomineralisation', 'non-fluoride hypomineralisation', and 'cheese molars' (1,2,3). Enamel hypoplasia (EH) can involve a quantitative defect in the enamel resulting from the disturbance of ameloblasts during matrix formation (4,5,6) and/or a qualitative defect caused by disturbance during initial calcification and/or maturation (4,5). The term molar incisor hypomineralisation (MIH) was accepted at the meeting of the European Academy of Paediatric Dentistry to define qualitative defects of the enamel affecting one to four FPMs in association with similar defects in permanent incisors and canines (7).

Clinically, the defects appear as opaque lesions ranging in colour from white to yellow or brown, with sharp demarcations between the affected and sound enamel (5). Posteruptive enamel breakdown may occur rapidly under masticatory forces, resulting in atypical cavities or even complete coronal distortion requiring extensive restorative treatment (8,9).

đaj, dugotrajno dojenje, niska težina pri rođenju, bolesti u ranom djetinjstvu (primjerice, vodene kozice, upala srednjeg uha, urinarne infekcije, tonzilitis, respiratorne bolesti), visoka temperatura, hipokalcijemija i dioksini (6, 10).

Svrha ovog istraživanja bila je odrediti klinička obilježja i moguće uzroke povezane s MIH-om u skupini djece u Turskoj koja su došla na pregled na Stomatološki fakultet Sveučilišta Marmara u Istambulu.

Materijali i metode

Odabir uzorka

Djeca koja su na Odjel dječje dentalne medicine Stomatološkog fakulteta Sveučilišta Marmara u Istambulu došla na pregled između travnja i kolovoza 2011. godine, slučajnim su odabirom uvrštena u ovo kontrolno istraživanje. Nakon toga je iskusan specijalist dječje dentalne medicine pregledao sve nove pacijente ne bi li uočio MIH. Kontrolna skupina (bez MIH-a) odabrana je nasumce, ovisno o tome jesu li djeca pri dolasku dobila parni redni broj.

Kriterij uključivanja

U istraživanje su bila uključena djeca s MIH-om na najmanje jednom prvom trajnom kutnjaku (FPM-u), sa zahvaćenim sjekutićima ili bez zahvaćenih sjekutića (5). Njihovi su roditelji nakon pregleda potpisali pristanak.

Kriteriji isključivanja

Djeca sa sindromima povezanima s razvojnim poremećajima cakline, zubnom fluorozom, EH-om, *amelogenesis imperfecta*, tetraciklinskim obojenjem, potpuno oštećenom krunom FPM-a, i/ili ako su tijekom procjene bila pod ortodontskom terapijom, isključena su iz istraživanja. Opaciteti koji su uočeni samo na sjekutićima ili su sjekutići bili restaurirani kompozitnim materijalom, a kutnjaci nisu bili zahvaćeni, nisu dijagnosticirani kao MIH.

Kriteriji za dijagnozu i stupanj MIH-a

MIH je dijagnosticiran klinički na temelju kriterija koje je opisao Weerheijm 2003. godine (5) (tablica 1.). On je stupnjeve MIH-a klasificirao kao:

– blage (ograničeni opaciteti bez potrebe za terapijom),
– umjerene (lezije na zubima s grubom i slomljenom caklinom),
– teške (hipomineralizirane lezije povezane s gubitkom caklinske i dentinske strukture; atipične restauracije koje zamjenjuju zahvaćeno tvrdo zubno tkivo; ekstrakcija zuba zbog teške demineralizacije) (11).

Kod svakog djeteta hipomineralizacija je procijenjena ovisno o najvišem uočenom stupnju na prvom trajnom kutnjaku ili na trajnim sjekutićima.

The aetiology of MIH remains unclear, but the proposed underlying factors include medical problems during pregnancy, pre-term delivery, long-term breastfeeding, low birth weight, diseases of early childhood (*e.g.* chicken pox, otitis media, urinary infection, tonsillitis, respiratory disease), high fever, hypocalcaemia, and dioxins (6,10).

The objective of the present study was to determine the clinical characteristics and possible associated causes of MIH in a group of Turkish children seeking dental care at the Dental School of Marmara University, Istanbul.

Materials and Methods

Sample selection

Children attending the Department of Paediatric Dentistry at the Dental School of Marmara University between April and August 2011 were included in this randomised controlled trial. A single well-trained paediatric dentist examined new patients at the department for MIH. A control (non-MIH) group was selected randomly from these children according to queue numbers that ended in an even number.

Inclusion criteria

Children with MIH in at least one FPM, with or without involvement of the incisors (5), who were present on the day of examination and whose parents had provided written informed consent, were included in the MIH group.

Exclusion criteria

Children with syndromes associated with enamel malformation, dental fluorosis, EH, amelogenesis imperfecta, tetracycline staining, completely damaged FPM crowns, and/or those undergoing orthodontic treatment at the time of assessment were excluded from the study. Opacities noted only on the incisors or cases in which the incisors had been treated with composite resin restorations with no molar involvement were not diagnosed as MIH.

Criteria for diagnosis and severity of MIH

MIH was diagnosed clinically based on the diagnostic criteria established by *Weerheijm, 2003* (5) (Table I). The severity of MIH was classified as mild (demarcated opacities with no need for treatment), moderate (lesions in teeth with rough and broken enamel), or severe (hypomineralised lesions associated with the loss of enamel and dentine structure; atypical restorations replacing affected hard tissue; extraction of teeth because of severe hypomineralisation) (11). For each child, hypomineralisation was graded according to the most severe defect observed in the FPMs or permanent incisors.

Tablica 1. Weerheijmovi dijagnostički kriteriji za molarno incizalnu hipomineralizaciju (MIH)
Table 1 Weerheijm diagnostic criteria for molar incisor hypomineralisation (MIH).

1. Ograničena područja opaciteta • Demarcated opacities
2. Posteruptivno otpadanje cakline • Post-eruptive enamel breakdown
3. Atipična restauracija • Atypical restoration
4. Vađenje kutnjaka zbog MIH-a • Extraction of molars due to MIH
5. Nenicanje kutnjaka i sjekutića • Eruption failure of a molar or incisor

Metode

Nakon uklanjanja ostataka hrane svitkom stanićevine, iskusan specijalist dječje dentalne medicine pregledao je pacijentima zube (FPM-s i sjekutiće) u vlažnom radnom polju zrcalom, sondom i dentalnim reflektorom.

Nakon toga popunjavao se detaljni upitnik kako bi se procijenila potencijalna povezanost između nastanka inzulta te ukupnog broja i tipova pogođenih zuba u skupini s MIH-om te dobile informacije o etiologiji defekata. Tako su roditeljima postavljena pitanja o prehrani djeteta, navikama četkanja zuba, majčinoj anamnezi (infekcije i bolesti) u trudnoći, porođaju (prijevremeni porođaj, komplikacije pri rođenju), alergijama, korištenju antibiotika, vrućicama (≥ 39°C) i infekcijama prije djetetove treće godine, kao što je to u literaturi opisano (1,6,10,12,13).

I u kontrolnoj su skupini medicinske informacije o djeci i njihovim majkama dobivene na isti način.

Analiza podataka

Podatci su prikupljeni i procijenjeni u programu Statistical Package for the Social Sciences (SPSS; ver. 20.0 for Windows; SPSS Inc., Chicago, IL, SAD). Izračunati su postotci, aritmetičke sredine, standardne devijacije (SDs) te Hi kvadrat test za analizu podataka. Vrijednost statističke značajnosti bila je postavljena na p<0,05.

Rezultati

Brojevi i postotci djece s MIH-om prema dobnim skupinama

Pregledano je ukupno 228 (104 djevojčice i 124 dječaka) djece u dobi od 7 do 14 godina. Kod pedeset i četiri (24 djevojčice i 30 dječaka; dob od 9,9 ± 1,godina) dijagnosticiran je MIH, pa ukupna prevalenciju iznosi 24 posto. U kontrolnoj skupini bila su 53 djeteta (25 djevojčica i 28 dječaka) u dobi od 10,08 ± 2,25 godina.

Prevalencija MIH-a prema spolu nije se značajno razlikovala (dječaci 56 %, djevojčice 44 %; Hi kvadrat test, p=0,465). U usporedbi s drugim dobnim skupinama, kod desetogodišnjaka je prevalencija MIH-a bila veća (6 –24 % prema 28 %).

Klinička obilježja MIH-a

Kod pacijenata s MIH-om bilo je zahvaćeno 98 posto kutnjaka i 80 posto sjekutića. Prevalencija prvih trajnih kutnjaka nije se značajno razlikovala kod onih u mandibuli u odnosu na maksilu (Hi kvadrat test, p> 0,05), ali je bila uočena velika razlika između sjekutića u maksili i mandibuli (Hi kvadrat test, p<0,05). MIH je zahvatio sva četiri kutnjaka samo u 39 posto (21/54) slučajeva, a kutnjake i sjekutiće u 46 posto (25/54). Od 54 djeteta s MIH-om 41 (76 %) je imalo samo ograničene opacitetne površine, bez ljuštenja ili atipičnih restauracija. Kod njih osam (15 %) uočene su atipične restauracije, a pet malih pacijenata (9 %) imalo je barem jedno posteruptivno ljuštenje cakline. MIH češće zahvaća kutnjake (n = 166, 55 %) nego sjekutiće (n = 137, 45 %; P < 0,001). Među sjekutićima, najčešće je bio oštećen zub 11 (70 %), a najrjeđe zub #41 (33 %). MIH zahvaća zube #21i

Methods

Following the removal of debris with cotton rolls, a well-trained paediatric dentist examined the index teeth (FPMs and incisors) while wet using a mirror, probe, and dental light while the patient was in a dental chair.

To evaluate the potential relationship between insult timing and the total number and types of teeth affected in the MIH group, and thus to gather information about the aetiology of the defects, a detailed questionnaire was administered. Questionnaire items addressed the children's eating and tooth-brushing habits, mothers' medical histories (infections and illnesses) during pregnancy, delivery characteristics (premature birth, birth complications), allergies, antibiotic use, fevers ≥ 39°C, and infections during the children's first 3 years of life, as described in previous studies (1,6,10,12,13). Medical information about children in the control group and their mothers was retrieved in the same way.

Data analysis

Data were collected, recorded, and evaluated using the Statistical Package for the Social Sciences (SPSS; ver. 20.0 for Windows; SPSS Inc., Chicago, IL, USA). Percentages, arithmetic means, and standard deviations (SDs) were calculated, and the chi-squared test was used to analyse the data. P-values < 0.05 were considered to indicate statistical significance.

Results

Numbers and percentages of children with MIH by age group

A total of 228 children (104 females, 124 males) aged 7–14 years were examined. Fifty-four children (24 females, 30 males; mean age ± SD = 9.9 ± 1.7 years) were diagnosed with MIH, yielding an overall prevalence of 24%. The control group consisted of 53 children (25 females, 28 males) with a mean age of 10.08 ± 2.25 years.

The prevalence of MIH did not differ significantly according to sex (males, 56%; females, 44%; chi-squared test, P = 0.465). Compared with other age groups, the prevalence of MIH was higher in 10-year-olds (6–24% *vs.* 28%).

Clinical characteristics of MIH

In patients with MIH, 98% of molars and 80% of incisors were affected. The prevalence of MIH did not differ significantly between the maxillary and mandibular molars (chi-squared test, P > 0.05), but a significant difference was found between the maxillary and mandibular incisors (chi-squared test, P < 0.05). MIH affected all four molars only in 39% (21/54) of cases and four molars and four incisors in 46% (25/54) of cases.

Of the 54 children with MIH, 41 (76%) had demarcated opacities only, with no breakdown or atypical restoration. Eight (15%) children had atypical restorations and five (9%) had at least one post-eruptive breakdown.

MIH affected molars (n = 166, 55%) more frequently than incisors (n = 137, 45%; P < 0.001). Among incisors, tooth #11 (70%) was affected most commonly and tooth

#11 mnogo češće nego zube #12, #22, #32, #31, #41, ili #42 ($P < 0,05$). Raspodjela pogođenih zuba nalazi se u tablici 2. Općenito su pronađeni blagi defekti (1. stupanj) kod 41/54 djeteta (76 %), umjereni defekti (2. stupanj) uočeni su kod njih 5/54 (9 %), a teški defekti (3. stupanj) zabilježeni su kod 8/54 (15%) djevojčica i dječaka. MIH najčešće izgleda kao blagi defekt kutnjaka ($P = 0,049$).

#41 (33%) was affected least frequently. MIH affected teeth #21and #11 significantly more frequently than teeth #12, #22, #32, #31, #41, or #42 ($P < 0.05$). The distribution of affected teeth is presented in Table II.

Overall, mild (grade 1) defects were found in 41/54 (76%) of affected children, moderate (grade 2) defects in 5/54 (9%), and severe (grade 3) defects were found in 8/54 (15%) children. MIH was expressed most frequently as mild defects in the molars ($P = 0.049$).

Tablica 2. Raspodjela molarno incizivne hipomineralizacije
Table 2 Distribution of molar incisor hypomineralisation.

Zubi • Teeth	n (%)
Maksilarni sjekutići (zubi #11, #12, #21, #22) • Maxillary incisors (teeth #11, #12, #21, #22)	83 (27)
Mandibularni sjekutići (zubi #31,# 32, #41, #42) • Mandibular incisors (teeth #31,# 32, #41, #42)	54 (18)
Maksilarni kutnjaci (zubi #16, #26) • Maxillary molars (teeth #16, #26)	73 (24)
Mandibularni kutnjaci (zubi #36, #46) • Mandibular molars (teeth #36, #46)	93 (31)
Ukupno • Total	303

Moguća prenatalna etiologija

Najčešća zabilježena prenatalna medicinska stanja kod skupine s MIH-om bila su bronhitis (8/54) i hipertenzija (5/54). Kod skupine bez MIH-a bronhitis je također bio najčešći (17/53). Bronhitis je bio češći u skupini bez MIH-a negoli u onoj s MIH-om ($P < 0,05$; tablica 3.).

Possible prenatal aetiology

The most frequently recorded prenatal medical conditions in the MIH group were bronchitis (8/54) and hypertension (5/54). In the non-MIH group, bronchitis (17/53) was also reported most frequently. Bronchitis was significantly more prevalent in the non-MIH group than in the MIH group ($P < 0.05$; Table III).

Tablica 3. Raspodjela prenatalnih varijabli kod djece s molarno incizivnom hipomineralizacijom (MIH-om) i bez nje
Table 3 Distribution of prenatal variables in children with and without molar incisor hypomineralisation (MIH).

Prenatalna varijabla • Prenatal variable	Skupina s MIH-om • MIH group n (%)	Skupina bez MIH-a • Non-MIH group n (%)	P
Hipertenzija • Hypertension	5 (9)	2 (3)	0.226
Vrućica • Fever	1 (2)	4 (7)	0.176
Dijabetes • Diabetes	1 (2)	3 (6)	0.302
Prerano rođenje • Premature birth	4 (7)	4 (7)	0.632
Bronhitis • Bronchitis	8 (15)	17 (32)	0.029*

Moguća postnatalna etiologija

Većina roditelja izjavila je da su njihova djeca (skupina s MIH-om: 46/54, 85 %; skupina bez MIH-a: 45/53, 84 %) pila antibiotike zbog dječjih bolesti ili drugih razloga. Često su navodili tonzilitis i vodene kozice ($P = 0,246$, $P = 0,267$), a vrućicu najčešće, i to u obje grupe ($P = 0,086$). Značajna razlika među skupinama uočena je ako su djeca konstantno uzimala lijekove ($P = 0,006$) i ako su oboljela od astme prije svoje treće godine ($P = 0,050$). Kod djece nije bilo pronađeno nikakvo drugo značajno medicinsko stanje u prvim trima godinama života ($P < 0,05$; tablica 4.).

Raspodjela stupnja MIH-a ovisno o medicinskom stanju

Proučavala se i povezanost stupnja MIH-a sa stanjima koja su se pojavljivala pojedinačno ili u različitim kombinacijama u medicinskoj anamnezi djece (tablica 5.). Tonzilitis je bio mnogo češći među djecom s 1. stupnjem MIH-a ($P < 0,05$).

Possible postnatal aetiology

Parents reported that most children (MIH group: 46/54, 85%; non-MIH group: 45/53, 84%) consumed antibiotics because of childhood diseases or other reasons. Tonsillitis and chicken pox were commonly reported illnesses ($P = 0.246$, $P = 0.267$), and fever was reported most frequently in both groups ($P = 0.086$). Significant differences between groups were observed in the numbers of children who consumed medicaments constantly ($P = 0.006$) and had asthma before the age of 3 years ($P = 0.050$). No other significant difference in medical histories in the first 3 years of life was observed ($P < 0.05$; Table IV).

Distribution of MIH severity by medical condition

MIH severity was examined with reference to conditions occurring separately and in various combinations in the children's medical histories (Table V). Tonsillitis was significantly more common among children with grade 1 MIH ($P < 0.05$).

Tablica 4. Raspodjela natalne/postnatalne varijable djece s molarno incizivnom demineralizacijom (MIH-om) i bez nje
Table 4 Distribution of natal/postnatal variables in children with and without molar incisor hypomineralisation (MIH).

Medicinska i obiteljska anamneza • Medical and family histories	Skupina s MIH-om • MIH group *n* = 54	Kontrolna skupina • Control group *n* = 53	*P*
Dječaci • Male	30	28	
Djevojčice • Female	24	25	
Bolesti majke tijekom trudnoće • Maternal illness during pregnancy	8	4	0.263
Korištenje lijekova tijekom trudnoće • Medicament consumption during pregnancy	8	3	0.107
Korištenje antibiotika prije dobi od tri godine •Antibiotic consumption before age of 3 years	46	45	0.516
Neprekidno korištenje lijekova • Constant medicament consumption	18	6	**0.006***
Vrućica u dobi od jedne godine • Fever in the first year of life	21 (39%)	13	0.086
Vodene kozice prije dobi od tri godine • Chicken pox before age of 3 years	15 (28%)	11	0.267
Upala uha prije dobi od tri godine • Ear infection before age of 3 years	7 (13%)	6	0.515
Tonzilitis prije dobi od tri godine • Tonsillitis before age of 3 years	27 (50%)	21	0.246
Astma prije dobi od tri godine • Asthma before age of 3 years	8 (15%)	2	**0.050***
Alergije prije dobi od tri godine • Allergies before age of 3 years	13	7	0.116
Komplikacije kod porođaja • Complications during birth	3(6%)	4	0.489

Tablica 5. Raspodjela medicinskih anamneza ovisno o težini molarno incizivne hipomineralizacije (MIH-a)
Table 5 Distribution of medical histories according to the severity of molar incisor hypomineralisation (MIH).

Bolest (i) • Illness(es)	MIH 1 *n* = 41 (76%)	MIH 2 *n* = 8 (15%)	MIH 3 *n* = 5 (9%)
Vodene kozice • Chicken pox	11	2	2
Upala uha • Ear infection	5	2	0
Vrućica • Fever	18	2	0
Tonzilitis • Tonsillitis	21	4	2
Astma • Asthma	5	1	2
Alergije • Allergies	11	1	1
Antibiotici + vodene kozice • Antibiotics + Chicken pox	10	1	2
Antibiotici + upala uha • Antibiotics + Ear infection	5	2	0
Antibiotici + vrućica • Antibiotics + Fever	17	2	0
Antibiotici + tonzilitis • Antibiotics + Tonsillitis	19	3	2
Antibiotici + alergije • Antibiotics + Allergies	10	1	0
Vodene kozice + upala uha • Chicken pox + Ear infection	1	0	0
Vodene kozice + vrućica • Chicken pox + Fever	5	0	0
Vodene kozice + tonzilitis • Chicken pox + Tonsillitis	3	1	1
Vodene kozice + alergije • Chicken pox + Allergies	4	0	0
Upala uha + vrućica • Ear infection + Fever	3	0	0
Upala uha + tonzillitis • Ear infection + Tonsillitis	3	1	0
Antibiotici + vodene kozice + upala uha • Antibiotics + Chicken pox + Ear infection	1	0	0
Antibiotici + vodene kozice + vrućica • Antibiotics + Chicken pox + Fever	5	0	0
Antibiotici + vodene kozice + tonzilitis • Antibiotics + Chicken pox + Tonsillitis	3	0	0
Antibiotici + vodene kozice + alergije • Antibiotics + Chicken pox + Allergies	4	0	0

Dentalno znanje

Roditelji 32 (60 %) djeteta s MIH-om i 29 (54 %) u skupini bez MIH-a izjavili su da njihova djeca četkaju zube jedanput na dan, a 21 (30 %) dijete u skupini s MIH-om i 25 (46 %) u skupini bez MIH-a čine to dva puta na dan. Odgovori na pitanja o prehrambenim navikama otkrili su da je većina djece (skupina s MIH-om – 24/54; skupina bez MIH-a – 28/53) jela pet ili više obroka na dan. Nisu se računali KEP-indeksi ni za mliječne ni za trajne zube, pa se iz raspoloživih podataka o dnevnim navikama ništa nije moglo zaključiti.

Dental knowledge

Parents reported that 32 (60%) children in the MIH group and 29 (54%) in the non-MIH group brushed their teeth once per day, and 21 (30%) children in the MIH group and 25 (46%) in the non-MIH group brushed their teeth twice a day. Enquiries about nutritional habits revealed that most children (MIH group, 24/54; non-MIH group, 28/53) had five or more meals per day. However, decayed, missing, and filled teeth (DMFT in primary teeth, DMFT in permanent teeth) values were not determined; no conclusion could be drawn from these data regarding daily habits.

Rasprava

Svrha ovog istraživanja bila je odrediti moguće etiološke čimbenike i karakteristike u skupini djece s MIH-om koja su došla na Odjel dječje dentalne medicine Stomatološkog fakulteta istambulskog Sveučilišta Marmara. U uzorku od 54 djeteta bio je podjednak broj dječaka i djevojčica. Dob od 7 do 14 godina odabrana je zato što do tada eruptiraju sva četiri trajna kutnjaka i većina sjekutića. U ovom je istraživanju prevalencija MIH-a bila, u odnosu na ostale dobne skupine, najviša kod desetogodišnjaka (28 %).

Prevalencija MIH-a

Premda se rezultati epidemioloških istraživanja iz drugih zemalja ne mogu neposredno usporediti zbog varijacija u kriterijima, odabiru uzorka, uključenim lezijama te etiološkim i okolišnim čimbenicima, prevalencija MIH-a u ovom istraživanju (24 %) može se uvrstiti u široki raspon (2,8 – 40,2 %) opisan u literaturi (14).

Proučavani uzorak sastojao se od malog broja djece koja dolaze na Odjel dentalne njege. Čak je moguće da je prevalencija MIH-a u ovoj skupini bila veća nego u općoj dječjoj populaciji. Turski Državni zavod za zdravstveno osiguranje omogućuje besplatne dentalne usluge u državnim bolnicama. Naš fakultet također omogućuje besplatnu dentalnu njegu za stanovnike Istambula, čime se možda može objasniti visoka prevalencija MIH-a u našem uzorku djece koja su potražila njegu u sustavu zdravstvene zaštite.

Kliničke karakteristike MIH-a

U ovom istraživanju nije pronađena razlika u zahvaćenosti MIH-om maksilarnih i mandibularnih kutnjaka.

Dobiveni rezultati slažu se s istraživanjima sa sličnom raspodjelom MIH-a na kutnjacima u oba zubna luka (3, 15, 16), ali se razlikuju od istraživanja u kojima se tvrdi da su MIH-om češće zahvaćeni mandibularni (12, 17) ili maksilarni kutnjaci (4, 18, 19). U skladu s rezultatima drugih istraživanja (17, 19), u ovome MIH pogađa maksilarne kutnjake češće nego mandibularne sjekutiće. Najčešće zahvaćeni zubi bili su sjekutići #11 (70 %), a najrjeđe #41 (33 %). MIH je zahvaćao zube #21 i #11 mnogo češće nego zube #12, #22, #32, #31, #41 i #42 ($P < 0,05$). Ovi rezultati u skladu su s ranijim istraživanjima provedenima u Turskoj (13). Kao i u ostalim istraživanjima (14,17), najviše je bilo blagih defekata (76 %). U dosadašnjim istraživanjima objašnjeno je da zub s MIH-om brzo propada u ustima, stoga manje zuba s blagim ili teškim MIH-om se tipično otkriju (3, 14, 17).

Pri pokušaju da se pronađu mogući etiološki čimbenici MIH-a važno je zapamtiti da između 28. tjedna intrauterino i deset dana nakon porođaja, ameloblasti počinju s amelogenezom kod prvih trajnih zuba koji se stvaraju, nakon kojih poslije slijede ostali zubi (20). Treba istaknuti da su ameloblasti najosjetljivije stanice u ljudskom tijelu, pa ako se njihova funkcija prekine privremeno ili trajno, tada, ovisno o vremenu inzulta, nastaje caklinska hipoplazija ili hipomineralizacija. Pokusi su pokazali da na caklinski matriks utječu pH, respiratorna acidoza, inhibicija proteolitičkih enzima i razvoja kristala hidroksilapatita, pa posljedično nastaje

Discussion

The aim of the present study was to determine the possible aetiological factors and characteristics of MIH in a group of Turkish children attending the Department of Paediatric Dentistry at the Dental School of Marmara University. The sample of 54 children contained almost equal numbers of males and females. The age range of 7–14 years was chosen for this study because all four FPMs and the majority of incisors have erupted in most children of this age. In the present study, the prevalence of MIH was higher in 10-year-olds (28%) than in other age groups.

Prevalence of MIH

Although the results of epidemiological studies from different countries are not directly comparable because of variations in criteria, sample selection, lesions included, and aetiological and environmental factors, the prevalence of MIH in this study (24%) fell within the wide range of values (2.8–40.2%) reported in the literature (14). However, the sample examined in this study comprised a small population of children attending our department for dental care. Thus, the prevalence of MIH may be higher in this group than in the general paediatric population. In Turkey, the government health insurance provides free dental care in government hospitals. Our university provides free access to health care for residents of Istanbul, which may explain the high prevalence of MIH in our sample of children who sought care through the health coverage system.

Clinical characteristics of MIH

In this study, no difference in the susceptibility of maxillary and mandibular molars to MIH was found. This result is in agreement with some studies reporting similar distributions of MIH in molars from both arches (3,15,16), but contrasted with other studies reporting that mandibular (12, 17) or maxillary (4,18,19) molars were affected more frequently. In agreement with the results of other studies (17,19), MIH affected the maxillary incisors more frequently than the mandibular incisors in the present study. The most and least frequently affected incisors were teeth #11 (70%) and #41 (33%), respectively. MIH affected teeth #21 and #11 significantly more frequently than teeth #12, #22, #32, #31, #41, and #42 ($P < 0.05$); this finding was similar to that of a previous study conducted in Turkey (13).

In agreement with other reports (14,17), most (76%) defects recorded in this study were mild. Previous studies have explained this finding with reference to the likelihood that an erupted tooth with MIH will deteriorate quickly; thus, fewer teeth with moderate or severe MIH are typically detected (3,14,17).

In an attempt to explain the possible aetiological factors in the MIH cases it is important to remember that between the 28th week *in utero* and the first 10 days of life, ameloblasts initiate amelogenesis in the first permanent teeth to be formed, the FPM, followed by other teeth later in time (20) and note that ameloblasts belong to the most sensitive cells of the human body. If their function is interrupted, temporarily or permanently, then depending on the time of insult,

caklinska hipomineralizacija (21). U ovom istraživanju pokušalo se odrediti utječu li određena prenatalna/postnatalna zdravstvena stanja na prevalenciju MIH-a.

Prenatalna stanja

U skupini s MIH-om prenatalni bronhitis i hipertenzija bili su češći negoli druge bolesti, a prenatalni bronhitis najčešći je bio u skupini djece bez MIH-a. Između prenatalnih stanja (primjerice, hipertenzije, dijabetesa, bronhitisa) i prisutnosti MIH-a nije pronađena korelacija. Taj rezultat slaže se s onima u dva ranija klinička istraživanja (10, 12). No ishod je bio različit u istraživanju na 33 djeteta s MIH-om (4) u kojemu je 15 posto sudionika prijavilo kronične bolesti majke tijekom trudnoće, primjerice, sifilis, hipertenziju, povišenu razinu glukoze u krvi i dugotrajno korištenje lijekova, premda u nedavnom istraživanju ista skupina (12) nije uspjela pronaći poveznice tih stanja s MIH-om. Druga medicinska stanja navedena u istraživanju Lygidakisa i suradnika (2008.b) (21) uključivala su majčin dijabetes, dugotrajno povraćanje i korištenje spazmolitičkih lijekova u kasnom gestacijskom dobu. Premda o tim stanjima prije nije bilo izviješteno, tvrde da dijabetes majke potiče hipokalcijemiju na kutnjacima i probleme sa skladištenjem kisika kod fetusa, što može imati za posljedicu caklinsku hipomineralizaciju.

Postnatalna stanja

Većina tih medicinskih stanja opisana je već u istraživanjima na manjem uzorku djece s MIH-om. U skupini od 21 djeteta s MIH-om, 67 posto njih imalo je različite respiratorne bolesti, poput bronhitisa, astme, pneumonije i infekcije gornjega dišnog puta (22).

U istraživanju u Švedskoj, gdje su se također koristili *kontrolnom* skupinom, 77 djece s MIH-om imalo je više medicinskih problema u dobi od jedne godine – najčešće su obolijevali od astme, upale pluća, upale srednjeg uha i infekcije gornjeg dišnog puta (12). U jednom istraživanju u Danskoj su 24 djeteta s MIH-om uspoređena s 21 djetetom u kontrolnoj skupini i dobivena je statistički značajna razlika u upali srednjeg uha, upali pluća, infekcijama i visokoj temperaturi tijekom prve četiri godine života (10). U jednom istraživanju provedenom u Istambulu istaknuto je da, od bolesti do dobi od tri godine, 55 posto djece s MIH-om i 19,4 posto bez MIH-a u anamnezama ima zabilježena stanja koja mogu uzrokovati loše opće stanje. Od djece s MIH-om njih 27 posto imalo je infekcije gornjih i donjih dišnih puteva, što je bilo značajno različito od skupine djece bez MIH-a. U tom istraživanju djeca s MIH-om imala su također značajno više bubrežnih infekcija (13).

U ovom istraživanju su tonzilitis i vodene kozice bile zajedničke bolesti, a visoka temperatura bila je najčešće postnatalno stanje u objema skupinama. Nije pronađena značajna

enamel hypoplasia or hypomineralisation occurs. Experiments have shown that conditions affecting the enamel matrix pH, i.e. respiratory acidosis and abnormal oxygen levels resulting from hypoventilation in various respiratory diseases, inhibit the action of the proteolytic enzymes and the development of the crystal hydroxyapatite resulting in enamel hypomineralisation (21). The present clinical study also attempted to determine whether certain prenatal/postnatal health conditions influenced the prevalence of MIH.

Prenatal conditions

Prenatal bronchitis and hypertension were reported more frequently than other diseases in the MIH group, and prenatal bronchitis was reported most frequently in the non-MIH group. However, no correlation between prenatal conditions (*e.g.* hypertension, diabetes, bronchitis) and the presence of MIH was found. This result is similar to those of two previous clinical studies (10,12). The results different from ours were those reported in a study of 33 children with MIH (4), where 15% of them recorded maternal chronic diseases during pregnancy, e.g. syphilis, hypertension, elevated blood glucose, and prolonged use of drugs. However, in a later study the same group could not find any association of these conditions with MIH (12). Other prenatal medical problems evident in the study of Lygidakis, *et al. 2008b* (21) included maternal diabetes, prolonged vomiting and use of spasmolytic medication in the late gestational weeks. Although these conditions have not been reported before, they stated that maternal diabetes produces hypocalcaemia in the mother and oxygen shortage problems for the fetus that may result in enamel hypomineralisation.

Postnatal conditions

The majority of these medical conditions have been reported previously in studies on smaller samples of MIH children. In a group of 21 children with MIH, 67% of them revealed various respiratory illnesses such as bronchitis, asthma, pneumonia and upper respiratory tract infections (22). In a Swedish study that also used a 'control' group, 77 children with MIH presented with more medical problems during their first year of life, most frequently asthma, pneumonia, otitis media and upper respiratory tract infections (12). In a Dutch study, 24 children with MIH were compared with 21 controls, revealing statistically different presence of otitis media, pneumonia, infections and high fever, during their first 4 years of life (10). In another study from Istanbul, it was reported that regarding the diseases in the first 3 years of life, 55% of MIH and 19.4% of non-MIH children had a disease history which may cause poor general health. From MIH children, 27% had suffered from upper and lower respiratory tract infections including bronchitis and this was significantly different from non-MIH children. In that study, MIH children were also significantly more related to renal infections (13). In the present study, tonsillitis and chicken pox were common illnesses and fever was the most frequently reported postnatal condition in both groups. However, no significant difference between the groups was observed with respect to medical histories in the first 3 years of life, except

razlika među skupinama u odnosu na medicinsku anamnezu u prve tri godine života, osim češćeg redovitog uzimanja lijekova i astme kod djece s MIH-om. Premda je u nedavnom istraživanju istaknuto da kod dojenčadi postoji povezanost između korištenja amoksicilina i MIH-a (8), malo je objavljenih dokaza koji to podupiru (23). U ovom istraživanju najčešći su defekti bili blagi opaciteti, što odgovara blagom stupnju ovog stanja. Istraživanja o stupnju MIH-a i stanja koja su se u medicinskoj anamnezi djece pojavljivala pojedinačno ili u kombinaciji, upućuju na to da je tonzilitis uobičajen kod djece s 1. stupnjem MIH-a.

Dentalno znanje

Premda su roditelji svjesni koliko je važno redovito četkati zube kako bi se spriječile bolesti, samo 30 posto djece s MIH-om i 46 posto djece bez MIH-a četka zube dva puta na dan. Budući da nismo određivali DMFT-vrijednosti, nismo mogli ništa zaključiti o korelaciji između defekata MIH-a i tih dnevnih navika (četkanje zuba i prehrambene navike). Prijeko je potreban dobro vođeni program nadzora nad djecom pogođenom MIH-om jer bi pridonio razvoju boljih preventivnih i terapijskih mjera za ovaj razvojni poremećaj trajnih zuba. Nedavno je William sa suradnicima (24) predložio vrlo jednostavan 6-stupanjski pristup vođenja:

- određivanje rizika,
- rana dijagnoza,
- remineralizacija (bolji pojam može biti mineralizacija; zub tijekom razvoja nije nikada *potpuno* mineraliziran, premda možda postoji komponenta demineralizacije zbog caklinskog karijesa lociranog na područja hipomineralizacije) i desenzibilizacija,
- prevencija zubnog karijesa i posteruptivnog ljuštenja cakline,
- restauracija ili ekstrakcija,
- održavanje.

Treba napomenuti da je pogođenu djecu i njihove roditelje vrlo važno savjetovati kad je riječ o prehrani i preventivi.

Zaključak:

- MIH je u Istambulu čest (24 %) kod djece u dobi od 7 do 14 godina. To upućuje na važnost prevencije i razumijevanje njegove etiologije. Kako bi se dobili valjani i pouzdani podatci o prevalenciji MIH-a, treba provesti istraživanje na reprezentativnom uzorku.
- Premda je etiologija MIH-a i dalje nejasna, pokazalo se da djeca s MIH-om često konstantno uzimaju lijekove i obolijevaju od astme do svoje treće godine.
- Potrebne su dugoročne prospektivne epidemiološke studije kako bi se ustrojila referentna baza podataka etioloških čimbenika koji bi omogućili dentalnim kliničarima bolju procjenu faktora rizika i odgovarajuće strategije za intervencije u slučaju MIH-a (25).

that constant medicament consumption and asthma were reported in a larger number of children with MIH.

Although a recent study associated the use of amoxicillin with MIH (8), there is little published evidence to support a link between prolonged infant medication and MIH (23).

In this study, light opacities were the most prevalent type of MIH defect, corresponding to the mild form of this condition. Examination of MIH severity with reference to conditions occurring separately and in combinations in the children's medical histories revealed that tonsillitis was common in children with grade 1 MIH.

Dental knowledge

Although parents were aware of the importance of regular tooth brushing to prevent dental disease, only 30% of children in the MIH group and 46% of those in the non-MIH group brushed their teeth twice per day. However, because we did not determine dmft or DMFT values, no conclusion could be drawn about correlations between MIH defects and these daily habits (tooth-brushing and nutritional habits).

A carefully managed recall program for children who are affected is essential and this would certainly help the development of better preventive and therapeutic measures for dealing with this developmental disturbance of permanent teeth. A very useful 6-step management approach for MIH has been proposed recently by William et al. (24):

- Risk identification,
- Early diagnosis,
- Remineralisation (a better term may be mineralisation; the tooth was never 'completely' mineralised during development although there may also be an element of demineralisation from enamel caries, superimposed upon the hypomineralised areas) and desensitisation,
- Prevention of dental caries and post eruptive enamel breakdown,
- Restorations or extractions,
- Maintenance.

It should be noted that it is very important to start approaching the affected children and their parents with the appropriate dietary and preventive advice as early as possible.

Conclusion:

- MIH was observed frequently (24%) in a group of children aged 7–14 years in Istanbul. This situation highlights the importance of preventing MIH in children and understanding its aetiology. In order to get valid and reliable knowledge about the prevalence of MIH, it is important to conduct a survey with representative populations.
- Although the aetiology of MIH remains unclear, constant medicament consumption and asthma during the first 3 years of life were reported frequently in children with MIH.
- Long-term prospective epidemiological studies are required to establish a reference databank of aetiological factors, which would allow dental clinicians to better assess risk factors and appropriate intervention strategies for MIH (25).

Abstract

Objective: To determine the clinical characteristics and possible medical causes of molar incisor hypomineralisation (MIH) in a group of Turkish children. **Materials and Methods:** A total of 228 children aged 7–14 years were examined in the Department of Paediatric Dentistry Dental School of Marmara University. Prenatal and postnatal medical data were recorded using a questionnaire. **Results:** MIH was observed in 54 (24%) children, 41 (76%) of whom had only demarcated opacities (grade 1). Eight (15%) children had atypical restoration (grade 2), and at least one post-eruptive breakdown (grade 3) was observed in five (9%) children. MIH affected molars (55%) more frequently than incisors (45%; $P < 0.001$). Prenatal bronchitis and hypertension were frequent in the MIH group. No significant difference in medical history during the first 3 years of life was observed between the MIH and non-MIH groups, except prolonged medicament consumption and asthma in the MIH group ($P < 0.05$). **Conclusion:** Although the aetiology of MIH remains unclear, constant medicament consumption and asthma during the first 3 years of life were reported frequently in children with MIH.

Received: October 21, 2013
Accepted: December 1, 2013

Address for correspondence
Betul Kargul
University Marmar
Faculty of Dentistry
Department of Pediatric Dentistry
Buyukciftlik Sok. No: 6
Nisantasi, Istanbul, Turkey.
Tel: +90 212 231 91 20
bkargul@marmara.edu.tr

Key words
Tooth Demineralization; Molar; Incisor

References

1. Koch G, Hallonsten AL, Ludvigsson N, Hansson BO, Holst A, Ulbro C. Epidemiologic study of idiopathic enamel hypomineralization in permanent teeth of Swedish children. Community Dent Oral Epidemiol. 1987 Oct;15(5):279-85.
2. Weerheijm KL, Groen HJ, Beentjes VE, Poorterman JH. Prevalence of cheese molars in eleven-year-old Dutch children. ASDC J Dent Child. 2001;68(4): 259-62. ASDC J Dent Child. 2001 Jul-Aug;68(4):259-62, 229.
3. Leppäniemi A, Lukinmaa PL, Alauusua S. Nonfluoride hypomineralizations in the permanent first molars and their impact on the treatment need. Caries Res. 2001 Jan-Feb;35(1):36-40.
4. Jälevik B, Norén JG. Enamel hypomineralization of permanent first molars: a morphological study and survey of possible aetiological factors. Int J Paediatr Dent. 2000 Dec;10(4):278-89.
5. Weerheijm KL: Molar incisor hypomineralisation (MIH). Eur J Paediatr Dent. 2003;4(3): 115-120.
6. Whatling R, Fearne JM. Molar incisor hypomineralization: a study of aetiological factors in a group of UK children. Int J Paediatr Dent. 2008 May;18(3):155-62.
7. Balmer R, Toumba J, Godson J, Duggal M. The prevalence of molar incisor hypomineralisation in Northern England and its relationship to socioeconomic status and water fluoridation. Int J Paediatr Dent. 2012 Jul;22(4):250-7.
8. Mathu-Muju K, Wright JT. Diagnosis and treatment of molar incisor hypomineralization. Compend Contin Educ Dent. 2006 Nov;27(11):604-10; quiz 611.
9. Lygidakis NA, Wong F, Jälevik B, Vierrou AM, Alaluusua S, Espelid I. Best Clinical Practice Guidance for clinicians dealing with children presenting with Molar-Incisor-Hypomineralisation (MIH): An EAPD Policy Document. Eur Arch Paediatr Dent. 2010 Apr;11(2):75-81.
10. Beentjes VE, Weerheijm KL, Groen HJ. Factors involved in the aetiology of molar-incisor hypomineralisation (MIH). Eur J Paediatr Dent. 2002 Mar;3(1):9-13.
11. da Costa-Silva CM, Jeremias F, de Souza JF, Cordeiro Rde C, Santos-Pinto L, Zuanon AC. Molar incisor hypomineralization: prevalence, severity and clinical consequences in Brazilian children. Int J Paediatr Dent. 2010 Nov;20(6):426-34.
12. Jälevik B, Norén JG, Klingberg G, Barregård L. Etiologic factors influencing the prevalence of demarcated opacities in permanent first molars in a group of Swedish children. Eur J Oral Sci. 2001 Aug;109(4):230-4.
13. Kusku OO, Caglar E, Sandalli N. The prevalence and aetiology of molar-incisor hypomineralisation in a group of children in Istanbul. Eur J Paediatr Dent. 2008 Sep;9(3):139-44.
14. Jälevik B. Prevalence and Diagnosis of Molar-Incisor- Hypomineralisation (MIH): A systematic review. Eur Arch Paediatr Dent. 2010 Apr;11(2):59-64.
15. Cho SY, Ki Y, Chu V. Molar incisor hypomineralization in Hong Kong Chinese children. Int J Paediatr Dent. 2008 Sep;18(5):348-52.
16. Chawla N, Messer LB, Silva M. Clinical studies on molar-incisor-hypomineralisation part 1: distribution and putative associations. Eur Arch Paediatr Dent. 2008 Dec;9(4):180-90.
17. Jasulaityte L, Veerkamp JS, Weerheijm KL. Molar incisor hypomineralization: review and prevalence data from the study of primary school children in Kaunas/Lithuania. Eur Arch Paediatr Dent. 2007 Jun;8(2):87-94.
18. Muratbegovic A, Markovic N, Ganibegovic Selimovic M. Molar incisor hypomineralisation in Bosnia and Herzegovina: aetiology and clinical consequences in medium caries activity population. Eur Arch Paediatr Dent. 2007 Dec;8(4):189-94.
19. Lygidakis NA, Dimou G, Briseniou E. Molar-incisor-hypomineralisation (MIH). Retrospective clinical study in Greek children. I. Prevalence and defect characteristics. Eur Arch Paediatr Dent. 2008 Dec;9(4):200-6.
20. Welbury RR. Paediatric Dentistry. Oxfored: Oxford University Press; 1997. p. 11-12.
21. Lygidakis NA, Dimou G, Marinou D. Molar-incisor-hypomineralisation (MIH). A retrospective clinical study in Greek children. II. Possible medical aetiological factors. Eur Arch Paediatr Dent. 2008 Dec;9(4):207-17.
22. van Amerongen WE, Kreulen CM. Cheese molars: a pilot study of the etiology of hypocalcifications in first permanent molars. ASDC J Dent Child. 1995 Jul-Aug;62(4):266-9.
23. Laisi S, Ess A, Sahlberg C, Arvio P, Lukinmaa PL, Alaluusua S. Amoxicillin may cause molar incisor hypomineralization. J Dent Res. 2009 Feb;88(2):132-6.
24. William V, Messer LB, Burrow MF. Molar incisor hypomineralization: review and recommendations for clinical management. Pediatr Dent. 2006 May-Jun;28(3):224-32.
25. Ghanim A, Morgan M, Mariño R, Bailey D, Manton D. Molar-incisor hypomineralisation: prevalence and defect characteristics in Iraqi children. Int J Paediatr Dent. 2011 Nov;21(6):413-21.