ORIGINAL RESEARCH

Enamel Hypomineralization: Prevalence, Defect Characteristics in Primary Dentition in a Northern Indian Region

Neeti Mittal[1], Nidhi Gupta[2], Achla Goyal[3]

Abstract

Background: No data is available on hypomineralization in the full complement of primary dentition.

Aim: To report on the prevalence and clinical presentation of enamel hypomineralization (EH) in the primary dentition.

Design: A cross-sectional observational study with a random sample of 948, 4–6-year-old schoolchildren of Gautam Buddh Nagar, Uttar Pradesh, India, was conducted after approval from the Institutional Ethics Committee. European Academy of Paediatric Dentistry (EAPD) (2003) criteria were employed to score EH in all primary teeth. A single experienced examiner conducted an entire clinical examination of the study population. Data were expressed as the prevalence, type, extent, and distribution. Further analyses were conducted to compare the prevalence and distribution of different types of lesions in affected subjects using student *t*-tests and analysis of variance (ANOVA).

Results: An overall prevalence of 7.51% (71/948) was reported. A total of 2.75 ± 1.735 teeth/subject were reported to be affected. The most common lesion was creamy white opacity ($p = 0.002$), while posteruptive breakdown (PEB) was observed in 40.85% (29/71) of affected subjects.

Conclusion: The prevalence of EH in primary dentition was 7.51%. Further studies mapping the prevalence as well as possible links with molar incisor hypomineralization (MIH) in other geographical locations of the world are required.

Keywords: Deciduous molar hypomineralization, Enamel hypomineralization, Hypomineralized second primary molars, Prevalence, Primary teeth.

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Introduction

The disturbances during the developmental phase of dentition may lead to qualitative or quantitative defects of enamel, which are known as developmental defects of enamel (DDE).[1,2] The qualitative defects of enamel constitute enamel hypomineralization (EH), which manifests clinically as distinct creamy white or yellowish-brown opacities with or without breakdown.[1,3] The most commonly encountered type of EH is molar incisor hypomineralization (MIH), that is, the hypomineralization affecting first permanent molars (FPMs) and permanent incisors (PIs).[3] The diagnostic criteria for MIH as per European Academy of Paediatric Dentistry (EAPD) are the presence of either of the demarcated opacities, enamel breakdown or atypical restorations on any of the FPMs.[4] Further, the only index teeth for identifying MIH are FPMs and PIs. As a result, the research on MIH is focused only on FPMs and PIs, while the rest of the teeth are not investigated thoroughly for hypomineralization. Whereas, there is a growing body of evidence that EH manifests in other teeth of permanent and primary dentition as well.[5–8] EH in primary teeth has been reported in second primary molars and is popularly known as hypomineralized second primary molars (HSPMs) or deciduous molar hypomineralization (DMH).[9,10] In this context, it is noteworthy that EH has been reported in almost every tooth on the permanent and primary dentition.[5–8] Almost all of the reports on EH in primary dentition have focused on HSPMs.[9–12] Thus, similar to hypomineralization in permanent dentition, that is, MIH, in primary dentition, the focus has also been on only one tooth, that is, HSPMs. The analogy between the two conditions may be owing to the overlap in the period of mineralization and the fact that a single insult can affect both FPMs and second primary molars.[9,11] da Silva et al.[6] and Goyal et al.[7] have identified EH in primary canines and primary first molars in addition to HSPMs. Based on the above-stated facts, it has been realized that there is a lack of data on the prevalence and clinical presentation of EH in primary dentition. Hence, the present study was planned to report on:

- The prevalence of hypomineralization in the primary dentition.
- The tooth-wise prevalence of hypomineralization in the primary dentition.
- Characteristics and extent of hypomineralization defects in individual teeth of primary dentition.

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Materials and Methods

Study Location

The present study was conducted in Gautam Budh Nagar District, Uttar Pradesh, in northern India. The city has variable groundwater fluoride levels (0.27–1.2 ppm).

Sampling

As no reports have been published on the prevalence of EH in primary dentition, the prevalence of HSPMs in the same study location as per a previously published study was taken as a guide to calculate the sample size. For a previously reported prevalence rate of 5.6%, 11 sample sizes at 95% confidence interval (CI) ($Z = 1.96$) for effect size 1.5 at 5% of estimated precision were calculated to be 253. However, as the present study aimed to report on the prevalence of EH in full primary dentition and not HSPMs only, it was decided to enroll a larger sample size of 1,000, 3–6-year-old children in public and private schools of Gautam Buddha Nagar. To ensure varied geographical and socioeconomic coverage, schools were randomly selected based on the number of schools in each area. Every fifth child in the school in the target age-group was included to ensure stratified random sampling.

Ethical Considerations

The present study was approved by the university's ethical committee and review board following ethical requirements for research on human subjects. This study is part of a larger study on EH, and ethical clearance for the entire study was sought (SU/2021/079). The permission letters for examining children were circulated to selected schools, and additionally, informed consents for participation in the present study were sought from parents of selected children.

Inclusion and Exclusion Criteria

Every fifth 3–6-year-old with positive informed consent present in school on the day of examination was included in the present study. Schools for children with special healthcare needs were not included. In case of missing teeth, if reasons for the absence of teeth could not be determined, the child was not included in the study. The presence of DDE (amelogenesis imperfecta, dentinogenesis imperfecta, tetracycline staining, or diffuse hypoplastic lesions i.e., fluorosis) on index teeth resulted in exclusion from the study.

Training and Calibration of the Examiner

The clinical examination of every child was carried out by a single investigator who is experienced and well-versed in the diagnosis and clinical management of MIH. The intraexaminer reliability, as measured by κ statistics, was 0.94%. Approximately, 10% of the sample was reexamined on the last day of clinical examination in each school to calculate the intraexaminer reliability.

Clinical Examination and Diagnosis

The clinical examination was performed after children rinsed their mouths to clean the teeth of any loose debris and allow a clear view of every tooth. A blunt probe and a mirror were used to examine wet and clean teeth under a source of artificial light. The defects were diagnosed and characterized using EAPD diagnostic criteria.[3,4] Buccal, lingual, and occlusal/incisal surfaces were examined for presence as well as the extent of individual defects. Later, it was categorized as >2/3rd, 1/3rd to 2/3rd, or <1/3rd of surface involvement.

Data Handling and Statistical Analysis

Prestructured and preprinted proformas with the provision to record demographic and clinical examination details of study participants were used to record data, which were then transported to Excel spreadsheets (Microsoft Office, Microsoft, Redmond, Washington, United States of America). Due care was taken to record the data with clarity to ease processing. However, the missing data resulted in exclusion from the study. Statistical analysis was done using Statistical Package for the Social Sciences (IBM, New York, United States of America). The prevalence and clinical characteristics were presented using descriptive statistics as number, percentage, and mean ± standard deviation (SD). Comparative statistics were computed using student *t*-test and analysis of variance (ANOVA) with significance set at $p < 0.05$.

Results

Demographic Details of Study Participants

A total of 948 subjects from a targeted sample size of 1,000 were examined, resulting in a response rate of 94.8%, as some of the selected children were absent on the day of the examination. The mean age of study participants was 5.21 ± 1.01 years, and there were more males ($n = 52$) than females ($n = 19$) (Table 1).

Prevalence and Distribution of Enamel Hypomineralization

A total of 71/948 subjects were affected by EH, resulting in an overall prevalence of 7.51%. A total of 59/948 subjects had HSPMs, and thus, the prevalence of HSPMs was 6.22%. A total of 2.75 ± 1.735 teeth/subject and 4.75 ± 4.136 surfaces/subject were reported to be affected. The maximum number of subjects ($n = 30/71$) had two affected teeth, and the maximum number of affected teeth was eight in two subjects (Fig. 1).

Tooth-wise Distribution of Enamel Hypomineralization

A total of 122/195 (62.56%) teeth were affected in the mandibular arch compared to 73/195 (37.44%) teeth in the maxillary arch.

Table 1: Demographics of study participants

Age (in years)	*Number (%)*	*Sex*	*Number (%)*
3 to <4	14 (19.7)	Female	19
4 to <5	16 (22.5)	Males	52
5–6	41 (57.7)		
Total		71 (100)	

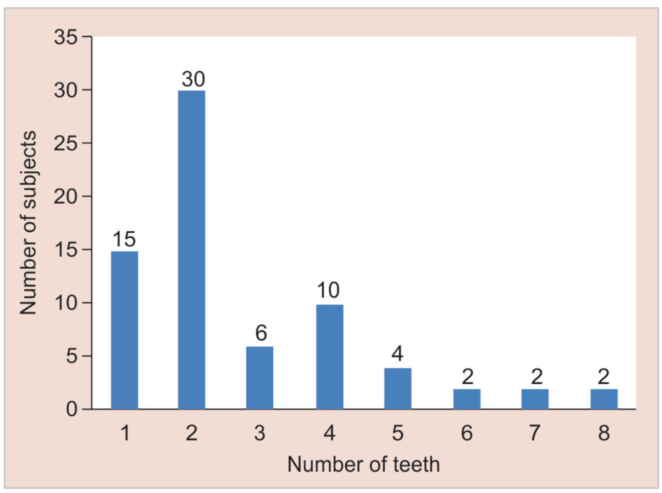

Fig. 1: Prevalence and distribution of EH—the maximum number of subjects ($n = 30/71$) had two affected teeth, and the maximum number of affected teeth was eight in two subjects

Significantly higher ($p = 0.007$; paired t-test) number of surfaces that had EH in the mandibular arch (1.71 ± 1.185) compared to the maxillary arch (1.03 ± 1.242). Overall, the second molars were the most commonly affected teeth (n = 131/195, 67.18%), and the most commonly affected tooth was the mandibular second molar (n = 91/195, 46.67%). The order of involvement of teeth was second molars (n = 131/195, 67.18%), first molars (n = 44/195, 22.56%), canines (n =18/195, 9.23%) and incisors (n = 2/195, 1.03%). It is noteworthy here that none of the subjects depicted EH in mandibular incisors (Fig. 2).

Characteristics and Distribution of Defects

Buccal surfaces were more commonly affected than occlusal and lingual surfaces ($p = 0.000$). Regarding the extent of lesions, there was no significant difference in the number of lesions as per surface area of involvement ($p = 0.226$). Creamy white opacity was the most common lesion ($p = 0.002$). In teeth affected with EH, a significantly higher number of surfaces were intact compared to those having a posteruptive breakdown (PEB) ($p = 0.000$). In teeth with PEB, a significantly higher number of surfaces had yellowish brown opacities than creamy white opacities ($p = 0.000$). Atypical restorations and loss of teeth/extractions owing to EH were not observed in any of the subjects (Table 2).

Intercomparison of Defect Characteristics in Various Tooth Types

Primary second molars were the most commonly affected teeth, with a significantly higher number ($p = 0.001$) of affected surfaces in second primary molars than in primary first molars and canines. Regarding the extent of individual lesions, a similar pattern of distribution of lesions was noted among three tooth types in comparison, except for lesions with 1/3rd to 2/3rd of surface

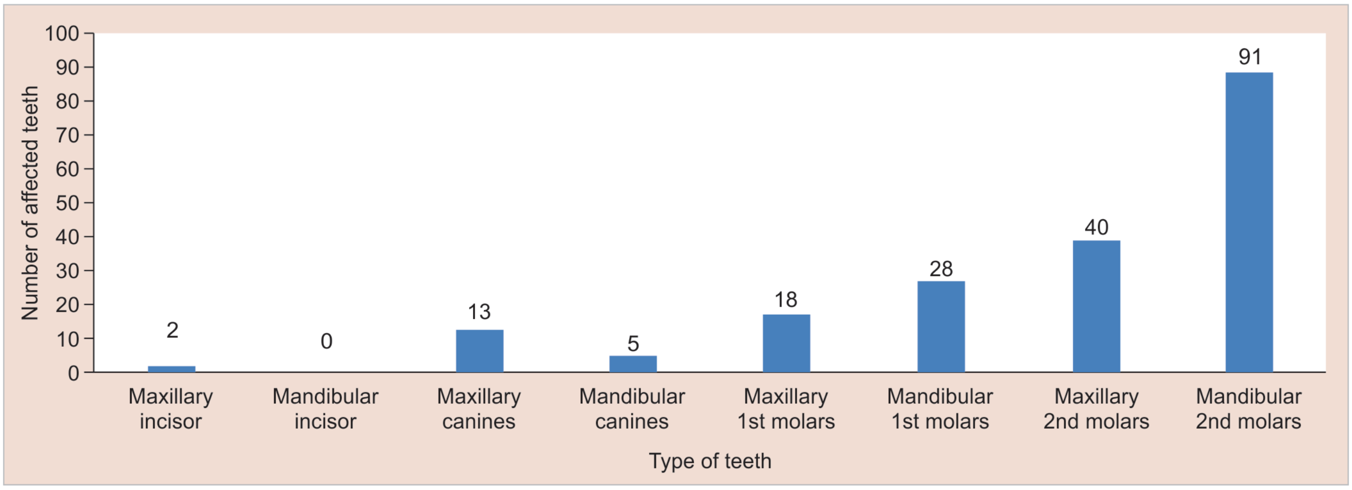

Fig. 2: Tooth-wise distribution of EH—the order of involvement of teeth was second molars (n = 131/195, 67.18%), first molars (n = 46/195, 22.56%), canines (n = 18/195, 9.23%), and incisors (n = 2/195, 1.03%)

Table 2: Characteristics and distribution of individual defects

Defect characteristic	*Number of affected surfaces (mean ± SD)*	*95% confidence intervals*	*p-value*
Distribution as per surface of involvement[#]			
Occlusal	1.77 ± 1.798	(1.352, 2.188)	0.000**
Buccal	2.21 ± 1.843	(1.781, 2.639)	
Lingual	0.76 ± 1.378	(0.439, 1.081)	
Distribution as per extent of lesion[#]			
<1/3rd of surface involvement	1.55 ± 2.936	(0.867, 2.233)	0.226
1/3rd to 2/3rd of surface involvement	2.28 ± 3.230	(1.529, 3.031)	
>2/3rd of surface involvement	1.30 ± 3.348	(0.521, 2.079)	
Distribution as per color of lesion[¶]			
Creamy white opacities	3.01 ± 3.635	(2.164, 3.856)	0.002**
Yellowish brown opacities	1.27 ± 2.091	(0.784, 1.756)	
Distribution as per presence of PEB[¶]			
Sound	3.69 ± 4.184	(2.717, 4.663)	0.000**
PEB	1.06 ± 1.567	(0.696, 1.424)	
Creamy white opacities with PEB	0.17 ± 0.560	(0.04, 0.3)	0.000**
Yellowish brown opacities with PEB	0.89 ± 1.489	(0.544, 1.236)	

[#], calculated on the basis of ANOVA, [¶], calculated on the basis of student t-test; **, highly significant p-value

Table 3: Intercomparison of defect characteristics and distribution in different types of teeth

Defect characteristics	*Second primary molars (n = 55) mean ± SD; 95% CI*	*First primary molars (n = 23) mean ± SD; 95% CI*	*Canines (n = 12) mean ± SD; 95% CI*	*p-value#*
Affected surfaces	5.15 ± 4.245; (4.028, 6.272)	2.57 ± 2.428; (1.522, 3.618)	1.58 ± 0.515; (1.253, 1.907)	0.001**
<1/3rd of surface involvement	1.36 ± 2.120; (0.8, 1.92)	1.26 ± 1.936; (0.424, 2.096)	0.58 ± 0.793; (0.076, 1.084)	0.458
1/3rd to 2/3rd of surface involvement	2.49 ± 3.150; (1.657, 3.323)	0.78 ± 1.242; (0.244, 1.316)	0.83 ± 0.937; (0.235, 1.425)	0.013*
>2/3rd of surface involvement	1.29 ± 2.859; (0.534, 2.046)	0.52 ± 1.163; (0.018, 1.022)	0.17 ± 0.577; (−0.196, 0.536)	0.199
Creamy white opacities	3.16 ± 3.495; (2.236, 4.084)	1.57 ± 1.409; (0.962, 2.178)	1.083 ± 0.793; (0.579, 1.587)	0.018*
Yellowish brown opacities	1.6 ± 2.439; (0.955, 2.245)	0.30 ± 0.876; (−0.078, 0.678)	0.5 ± 0.905; (−0.075, 1.075)	0.02*
Surfaces with PEB	1.29 ± 1.641; (0.856, 1.724)	0.29 ± 0.765; (−0.04, 0.62)	0	0.001**

#, calculated on the basis of ANOVA; *, significant *p*-value; **, highly significant *p*-value

involvement, which were significantly more common in second primary molars ($p = 0.001$). As second primary molars were the most commonly affected teeth with the maximum number of affected surfaces, creamy white opacities and yellowish brown opacities were also significantly more common in second primary molars compared to primary first molars and canines. None of the surfaces was observed to have PEB in canines. The primary first molars depicted significantly less incidence of PEB than the second primary molars ($p = 0.001$) (Table 3).

Discussion

An excellent response rate of 94.8% was observed in the present study, and the stratified random sampling approach was employed for the recruitment of the study population. Hence, the sample can be considered to be representative of the general population of the study area. The widely accepted EAPD criteria recommended for the evaluation of MIH were employed for the identification and scoring of EH on primary teeth.[3,4] The idea behind choosing the above-stated criteria was to allow a comparative evaluation of the severity of EH with MIH in case the same cohorts are followed in the future. Further, the EAPD criteria have been extensively employed in several published reports on HSPMs,[9–14] and the same criteria were used in the present study to ensure ease and reliability of comparison with findings on HSPMs in the present study with previously published data.

In previously reported studies on HSPM, a variety of light sources have been used, including natural light and artificial light sources.[12] The artificial light source offers uniform and reproducible light intensity for ease of observation and identification, while the natural light source is variable depending on weather conditions, and the low light conditions may lead to underreporting. In light of these facts, an artificial light source was used for easy identification and reproducibility of findings. Further, there has also been heterogeneity in the size of lesions to be included as affected. Most of the studies considered lesions ≤1–2 mm as sound.[12] In the present study, defects ≤2 mm were considered sound.

The present study is the very first study to report on the prevalence and distribution of EH in primary dentition. Previously, Goyal et al.[7] published their findings on the presence of hypomineralization in primary teeth other than HSPMs. However, Goyal et al.[7] evaluated only those subjects who had HSPMs, and the rest of the study population was not examined for EH presence on other primary teeth. Thus, their study did not represent the overall prevalence of EH in primary dentition as the sample was not representative of the study population but subjects with HSPMs. To simplify, their study reported the concomitant involvement of other primary teeth in subjects with HSPMs. In light of the above-stated facts, the present study is the very first to report on the prevalence of EH in primary dentition, so a direct comparison of the overall findings of the study with those of Goyal et al.[7] was not possible. da Silva et al.[6] reported on the prevalence of HSPMs and hypomineralized primary canines (HPC) in Brazilian schoolchildren, and their study population reported a prevalence rate of 6.48 and 2.22% for HSPMs and HPCs, respectively. These figures are very much in agreement with the findings of the present study. It is noteworthy here that the Brazilian study[6] also did not report the overall prevalence of EH in the primary dentition but selectively reported the presence of EH in primary canines and second molars only in a wider age-group of 6–11-year-olds. The concurrence of hypomineralization in other teeth of primary dentition (first primary molars and canines) and HSPMs may be due to overlap in their period of *in utero* development. The *in utero* development of primary first molars, second molars, and canines occurs during 14.5–17, 16–23.5, and 15–18 weeks, respectively.[15] The study location is part of a geographical area in Delhi, NCR region of northern India. The reported prevalence rate of 6.22% for HSPMs in the present study is almost similar to the previously reported prevalence of 5.9% in the same geographical area.[11] Two other Indian studies reported prevalence rates of 4.88 and 5%.[16,17] However, another study from northern India reported a higher prevalence of 7.9%.[7] Hence, the findings of the present study are in line with previously published reports on the Indian population.[7,11,16,17] When a global comparison of the reported prevalence rate of 6.22% for HSPMs in the present study was made, it was realized that the observed prevalence of HSPMs was similar to studies by Ghanim et al.[18] and Elfrink et al.[10] However, Elfrink et al.,[10] Negre-barber et al.,[19] and Costa-Silva et al.[20] reported a much higher prevalence of HSPMs, that is, 9, 14.5, and 20.14%, respectively. In this regard, it is noteworthy that the prevalence of MIH is also much higher in these regions than it is in the Indian subcontinent.[7,11] The observed differences in the prevalence of HSPMs in various studies can be attributed to methodological heterogeneity, such as sample size and sampling strategies, variable age-groups, operator calibration or interexaminer testing or inherent differences in the study population, such as ethnicity and genetic composition.

Demarcated opacities were the most commonly observed lesion type in the study population, and among demarcated opacities, creamy white opacities were most commonly observed. This finding is in concordance with findings from previously published reports on the Indian population by Goyal et al. in 2019 and Mittal et al. in 2015.[7,11] PEB was reported in 40.85% (29/71) of subjects in the study population, and this proportion is higher than reported rates of 21.1 and 30.2% for PEB in HSPMs as reported by Goyal et al.[7] and Mittal et al.,[11] respectively. The plausible explanation for this could be that Goyal et al.[7] and Mittal et al.[11] presented this data for HSPMs only, while in the present study, all teeth of primary dentition were included. The first primary molars erupt earlier than the second primary molars and are more likely to undergo breakdown owing to prolonged exposure to masticatory forces. Further, an interesting observation was that we did not observe any atypical restorations in our study population. It is to be noted here that the prevalence of PEB was 3.06% (29/948). Further, the atypical restorations have been reported to be least prevalent among all types of hypomineralization defects, and that's why they might not have been reported in the present study. The most commonly involved surfaces were buccal surfaces compared to occlusal and lingual surfaces. These findings are again in agreement with previously published literature.[7,11] It is worth mentioning here that PEB was not reported in canines, and this finding is in agreement with the findings of da Silva et al.[6] where significantly fewer breakdowns were observed in primary canines compared to second primary molars. One simple explanation for this observation is that in canines, the most commonly affected surface is the buccal surface, and the lesions are not commonly observed on occlusal/incisal surfaces, and the buccal surfaces aren't much exposed to masticatory forces compared to occlusal/incisal surfaces.

Early identification of EH in primary dentition is important as hypomineralization in primary teeth has been identified as a risk factor for MIH.[12] Not only HSPMs but HPCs have also been identified as a risk marker for MIH. da Silva et al. reported a significant association between HSPM/HPC and MIH ($p < 0.001$) in 1963 Brazilian schoolchildren aged 6–11 years old.[6] The authors concluded that the children with HSPM/HPC are six times more likely to develop MIH as the odd's ratio for MIH based on HSPM was 6.31 (95% CI, 2.29–15.13) and based on HPC was 6.02 (95% CI, 1.08–33.05). However, in the present study, no attempt was made to study the association between hypomineralized primary teeth and MIH or hypomineralized FPMs as in the current study, a younger age-group of 3–6 years was recruited, and FPMs have not erupted in many subjects in the study population. However, analyzing the association between HSPMs and MIH was not an objective of the present study as it has already been observed in many published reports, and Garot et al., in their meta-analysis, reported an odds ratio of 4.66 (95% CI, 2.11–10.26; $p < 0.0001$) for MIH in subjects with HSPMs.[12]

Keeping in mind the developmental stage of children, the recommended age for identification of HSPMs is 5 years, which is when children are expected to have the emotional maturity to allow thorough dental examination and accurate diagnosis.[10] However, the present study aimed to examine hypomineralized primary teeth other than HSPMs. As primary incisors and primary first molars erupt earlier than second primary molars, the younger age-group of 3–6 years was chosen for examination. In older children, as teeth have been exposed to masticatory forces for a longer period, it is well anticipated that the incidence of PEB and caries will increase, which may interfere with the accurate observation of EH in the primary dentition. In this context, Garot et al. also suggested that with increasing age, various factors, such as caries, breakdown or wear, can obscure the observation of hypomineralization.[12]

All sets of clinical examinations were conducted in school settings. Although the school environment offers a nonthreatening ambience and the children are more cooperative, the examination in the dental chair may be more accurate and allow for a more detailed view. This remains one of the limitations of the present study.

The present study adds new knowledge on the prevalence of EH in primary dentition. The findings of the present study show that HSPM constituted 67.18% of affected teeth, while the rest, 32.82% of affected teeth, were primary incisors, canines and first molars. This observation of the present study highlights the fact that observing only second primary molars for hypomineralization will lead to underreporting of EH in the primary dentition. Further studies mapping the prevalence of MIH and possible links with it in other geographical locations of the world are required.

Conclusion

The prevalence of EH in primary dentition was 7.51% in the study population. Further studies mapping the prevalence of MIH and possible links with it in other geographical locations of the world are required. The order of involvement of teeth was second molars (67.18%), first molars (46.67%), canines (9.23%), and incisors (1.03%).

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