Management of Molar-Incisor-Hypomineralisation by General Dental Practitioners

Part 1: Diagnosis

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In Brief Points:

- General dentists are not familiar with the terminology for hypomineralisation of second primary molars (HSPM), in addition to using the term hypomineralisation and hypoplasia interchangeably

- Dentists should be aware that the presence of caries may make it more difficult to diagnose MIH

- Postgraduate and undergraduate education should ensure that dentists are skilled in avoiding the above pitfalls when diagnosing MIH

Abstract (200)

Introduction: Molar-incisor-hypomineralisation (MIH) affects 1 in 6 children in the UK. For the majority of patients who have mild MIH, this should be managed in primary care.

Aims: to assess UK based general dental practitioners (GDPs) ability to diagnose MIH when presented with multiple clinical vignettes.

Design: An electronic vignette survey was designed with use of clinical photographs - six cases had MIH and/or hypomineralised second primary molars (HSPM) (seven possible diagnoses). Four control cases showing caries, fluorosis, amelogenesis imperfecta and dentinogenesis imperfecta were also included. Participants were UK based GDPs. The survey was distributed by email and across social media platforms. Data collection occurred between February and May 2019.

Results: 76 GDPs completed the survey. 68.4% of participants were female (n=52). 83% (n=63) of participants graduated after the year 2000. The number of accurate diagnoses for each case were as follows – mild MIH (molars/incisors) 65.79%; mild MIH (molars only) 3.95%; HSPM & MIH (HSPM result) 0%; HSPM & MIH (MIH result) 50%; Severe MIH (post-eruptive breakdown) 63.16%; Severe MIH (caries) 31.58%; HSPM 3.95%.

Conclusion: GDPs are able to accurately diagnose MIH best when both incisors and molars are affected, and caries is not present.

Words: 196

Introduction

Molar-incisor-hypomineralisation (MIH) is a qualitative defect of enamel which presents as demarcated opacities on first permanent molars (FPM) and incisor teeth.[1] It has a worldwide prevalence of 14.2%,[2] with a prevalence of 15.9% reported in the North East of England.[3] Recent papers in the British Dental Journal and by the British Society of Paediatric Dentistry have indicated that MIH should primarily be managed by General Dental Practitioners (GDPs), with only severe cases requiring specialist care.[4-6]

Several papers have been published in the UK discussing management options for MIH,[4 7 8] however this is complicated by difficulty in diagnosis.[5] MIH can present with demarcated cream, yellow or brown patches, can be asymptomatic or acutely sensitive, and severely affected children may have teeth with a lack of any normal looking enamel, which is prone to post-eruptive breakdown (PEB).[9] Patel et al recently discussed the key difference between hypomineralisation and hypoplasia.[5] Hypoplasia is a defect of enamel quantity, which means the shape of the tooth is altered, often presenting with pits or striations. The enamel itself will appear shiny and hard, unlike a MIH tooth with PEB where the enamel is rough and porous. Other conditions such as fluorosis, amelogenesis imperfecta and dentinogenesis imperfecta can be distinguished from MIH with a good family and fluoride history, and from the appearance across both dentitions.[10 11]

MIH teeth are more prone to caries due to the lower mineral content and can be acutely sensitive.[12 13 14] Early diagnosis of MIH by GDPs is key in order to implement prevention strategies for children of increased concern, for symptomatic relief[15-17], timely restorative intervention or referral to specialist providers when necessary.

Despite its high prevalence, in a recent survey in the UK, only 57% of GDPs felt confident in diagnosing MIH.[18] Other surveys around the world have found similar levels of confidence in diagnosis ranging from 51.1% in Iraq,[19] to 92.9% in Australia.[20] The evidence to date from across the world indicates many GDPs do not feel confident in diagnosis and are unsure of the correct management of these patients.[19 21-23] No previous studies have assessed the diagnostic ability of GDPs when confronted with MIH. The aim of this study was to assess UK based GDPs ability to diagnose MIH when presented with multiple clinical vignettes.

Materials & Methods

An electronic vignette survey was designed, piloted and refined in discussion with several GDPs who worked locally.

Ten clinical vignettes were selected after searching the available photography database, with appropriate consent. A shortlist of cases were selected to ensure a spectrum of MIH presentations. Cases included: mild MIH (molars only), mild MIH (incisors and molars), hypomineralised second primary molars (HSPM), MIH and HSPM, severe MIH with PEB of molars, and severe MIH with caries of molars. Control cases demonstrated: caries, fluorosis, amelogenesis imperfecta, and dentinogenesis imperfecta. The final cases selected were reached by consensus opinion of consultants in restorative and paediatric dentistry, and a speciality trainee in paediatric dentistry. The cases were then quality assured by members of CONNECT (Child Oral health NatioNal rEearch CollaboraTive) to ensure clear diagnosis.

Clinical photographs were supplemented by a description of the patient's complaint and relevant history, to aid diagnosis. Participants were asked to give one or two 'hard tissue' diagnosis for each case, as appropriate. They did not need to specify affected teeth.

Figure 1-3. Clinical photographs of a child with MIH and HSPM. Caption read: 'This 9 year-old-girl has no complaints but is very anxious and jumpy in the dental chair. There is no family history of similar looking teeth.'

Ethical approval was granted from University of Liverpool Ethics Committee, Liverpool, UK (project number 4561). Participants gave consent for participation at the start of each survey.

GDPs were selected from all countries of the UK. GDPs were selected using a randomly generated postcode for each postcode area of that country, and by selecting the nearest geographical dental practice to this. The number of GDPs contacted was weighted according to the number of GDPs on the GDC register in each country. The survey was also shared on social media platforms. UK based GDPs who regularly treated children were included. Dentists on the specialist register for any dental speciality were excluded.

The primary outcome was whether GDPs were able to accurately diagnose MIH/HSPM. In the six MIH cases, there were seven potential diagnoses of either MIH and/or HSPM. Answers were considered accurate if the participant used the terms 'molar incisor

hypomineralisation', 'MIH', 'hypomineralised second primary molars', 'HSPM', 'deciduous molar hypomineralisation' or 'DMH'.

The secondary outcomes were to analyse the inaccurate diagnoses for MIH/HSPM qualitatively and to the assess self-reported confidence in diagnosis of MIH in comparison to their accuracy across the six cases.

Qualitative analysis of each case was completed using thematic analysis with an inductive approach. The number of responses falling into each theme, including accurate diagnoses, was analysed for each case and expressed as percentages.

Following the vignettes, GDPs were asked to report their confidence in diagnosis of MIH as 'very confident', 'confident', 'slightly confident' and 'not confident at all'. This was dichotomised into two groups, and overall accuracy for the six cases was compared with reported confidence. The Mann Whitney U test for non-parametric results was used to look for differences between groups in relation to confidence and also in relation to postgraduate qualifications. All quantitative analysis was completed using SPSS for Windows (v25.0)™. Significance was set at $p < 0.05$.

Results

Data was collected electronically between 11th February and 14th May 2019 using Qualtrics™ survey software (SAP, Utah). Surveys were sent on two occasions at two-week intervals to

selected GDPs from across the UK by email and was also shared on social media platforms Facebook and Twitter.

Seventy-six GDPs completed the diagnosis section of the survey; further vignettes exploring treatment planning will be discussed in the second paper of this series. Response rate cannot be estimated since the total sample size is unknown. Prior to dissemination on social media 22 participants (28.9%) were recruited via email. It is not possible to determine the final recruitment numbers from email and social media as all participants accessed the survey through the same hyperlink.

Of the 76 participants, most were in the 20-29 age group (38.2% n=29), 35.5% were in the 30-39 age group (n=27), 18.4% were in the 40-49 age group (n=14), 6.6% were in the 50-59 age group and 1.3% were in the 70+ age group (n=1). No participants were in the 60-69 age group. 68.4% of GDPs were female (n=52). Table one shows when participants graduated.

The majority of respondents worked in England (80.26% n=61), with 17.10% from Scotland (n=13), and 1.32% from both Wales (n=1) and Northern Ireland (n=1).

The majority of participants completed dental school in the UK (90.8% n=69), whilst 9.2% (n=7) completed undergraduate degrees elsewhere. Around half of participants had postgraduate dental qualifications (54.0% n=41). Only 18.4% (n=14) of participants stated that they had experience of working within a paediatric dentistry department after graduation and 5.3% (n=4) currently worked part time within a paediatric dentistry department. Table one shows when participants graduated.

Year of Graduation	Percent	Number
2011-2018	54.0%	41
2001-2010	29.0%	22
1991-2000	9.2%	7
1981-1990	6.6%	5
1971-1980	0.0%	0
1970 or earlier	1.3%	1

Table 1. Year of graduation from dental school.

Three main themes and five subthemes were identified. The hypomineralisation/hypoplasia group contained diagnoses which included the correct diagnosis of MIH or molar-incisor-hypomineralisation, but also diagnoses which could be considered partially correct such as 'hypomineralisation'. Hypoplasia was considered in this group as some GDPs gave the diagnosis 'molar-incisor-hypoplasia', and therefore it cannot be guaranteed that those using the acronym 'MIH' are using the term correctly.

The second theme was 'other dental hard tissue defects' which included other enamel developmental defects such as amelogenesis imperfecta but also acquired 'defects' such as erosion and caries.

The third theme was other diagnoses, which were not dental hard tissue diagnoses. These included odontogenic infection and comment of orthodontic need or malocclusion. Figure four shows the themes, subthemes and codes identified.
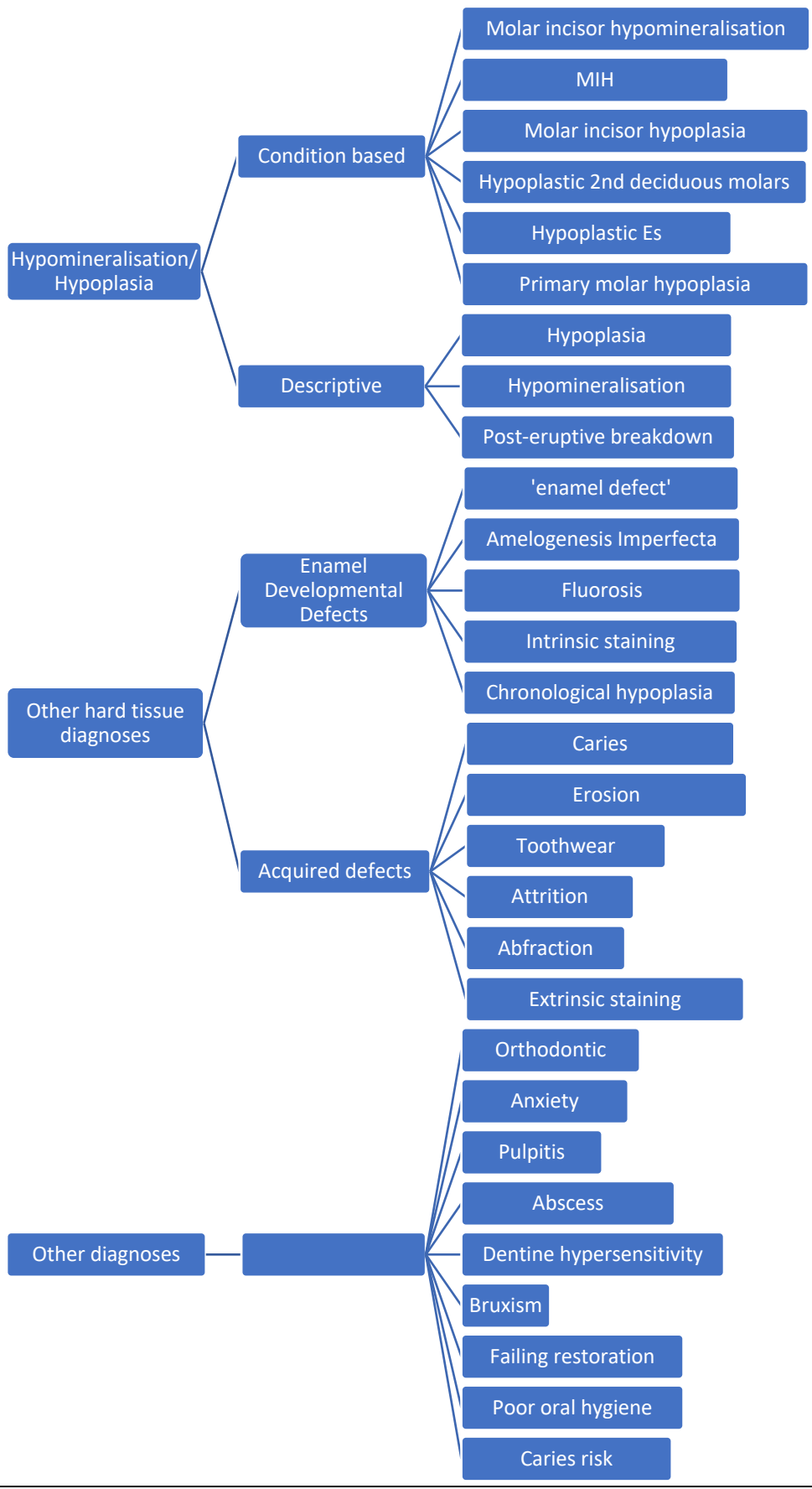
Figure 4. Themes, subthemes and codes identified from diagnoses

Hypomineralisation/ Hypoplasia

    Condition based

'Molar-inciosr-hypoplasia' was commonly used. Where the term MIH was used, it was not always clear whether the participants understood that 'H' was for hypomineralisation. Where hypoplasia was used it was not obvious whether this was because GDPs thought that the case showed hypoplasia or whether GDPs use the term interchangeably to mean both hypomineralisation and hypoplasia.

'Hypomineralisation of 6's and hypoplastic incisors'

(AB, Feb 24, 2019)

'Hypoplastic enamel could be MIH'

(HD, March 24, 2019)

When considering HSPM affected teeth, the terminology was varied. Many GDPs chose to use the term MIH. Again, like for permanent teeth, hypoplasia was used frequently in place of hypomineralisation.

'MIH possible febrile illness during developmental stages of Es and 6s and 1s'

(DG, February 12, 2019)

'Mild MIH'

(BA, March 13, 2019)

Descriptive

Some GDPs did not use condition type diagnoses but identified that there was either hypomineralisation or hypoplasia. Some showed increased knowledge of aetiology and disease processes, for example commenting on disruption of amelogenesis, or commenting on PEB, which suggests knowledge that hypomineralised teeth can fracture under normal occlusal forces.

'Hypoplastic 6's? Systemic disease during development of the 6's'

(GU, March 13, 2019)

'Molar hypomineralisation with post-eruptive breakdown'

(WF, April 25, 2019)

Other Hard Tissue Defects

Enamel Developmental Defects

Some GDPs identified that the appearance was not caries but were not familiar with the appearance of MIH, and diagnosed different enamel developmental defects.

'Fluorosis' (EH, April 26 2019)

Acquired defects

Other GDPs gave hard tissue diagnoses for more commonly seen disease such as caries and toothwear.

'Caries in deciduous teeth 55, 75, 85. Possible caries in 16 and 46. Restored 65 with possible secondary caries. Non cariogenic tooth surface loss 64'

(WN, February 15, 2019)

Other diagnoses

Some GDPs may have found it difficult to make a hard tissue diagnosis, and therefore gave alternative diagnoses based on other information seen in the photos such as malocclusion or patient symptoms described in the text.

'Caries URE and LRE – high risk, spacing upper arch IOTN 4d' (FY, February 18, 2019)

'Dentine hypersensitivity, abfraction' (DD, February 11, 2019)

'Bruxism' (LS, March 13, 2019)

As part of the qualitative analysis the answers given were coded into categories and quantitative analysis was undertaken based on the groups of answers given as shown in table

two. Where a participant put more than one answer, the answer which was most accurate was recorded using a hierarchical scale with 'correct' the best and 'other diagnosis' the worst. Figure five shows the spread of answers for each case.

Category Hierarchical Scale	Examples
Correct	Molar incisor hypomineralisation (MIH), hypomineralised second primary molars (HSPM), deciduous molar hypomineralisation (DMH)
Hypomineralisation/Hypoplasia (Hypo)	Hypoplasia, hypomineralisation, molar incisor hypoplasia, hypocalcified
Other enamel developmental defects (EDD)	Amelogenesis Imperfecta, fluorosis,
Acquired hard tissue defects (Acquired)	Caries, erosion, toothwear, attrition, abfraction
Other diagnoses (Other)	Anxiety, dentine hypersensitivity, pulpitis, poor oral hygiene, bruxism, caries risk, orthodontic IOTN

Table 2. Categories of diagnosis in hierarchical scale with 'correct' most accurate and 'other diagnoses' the least accurate
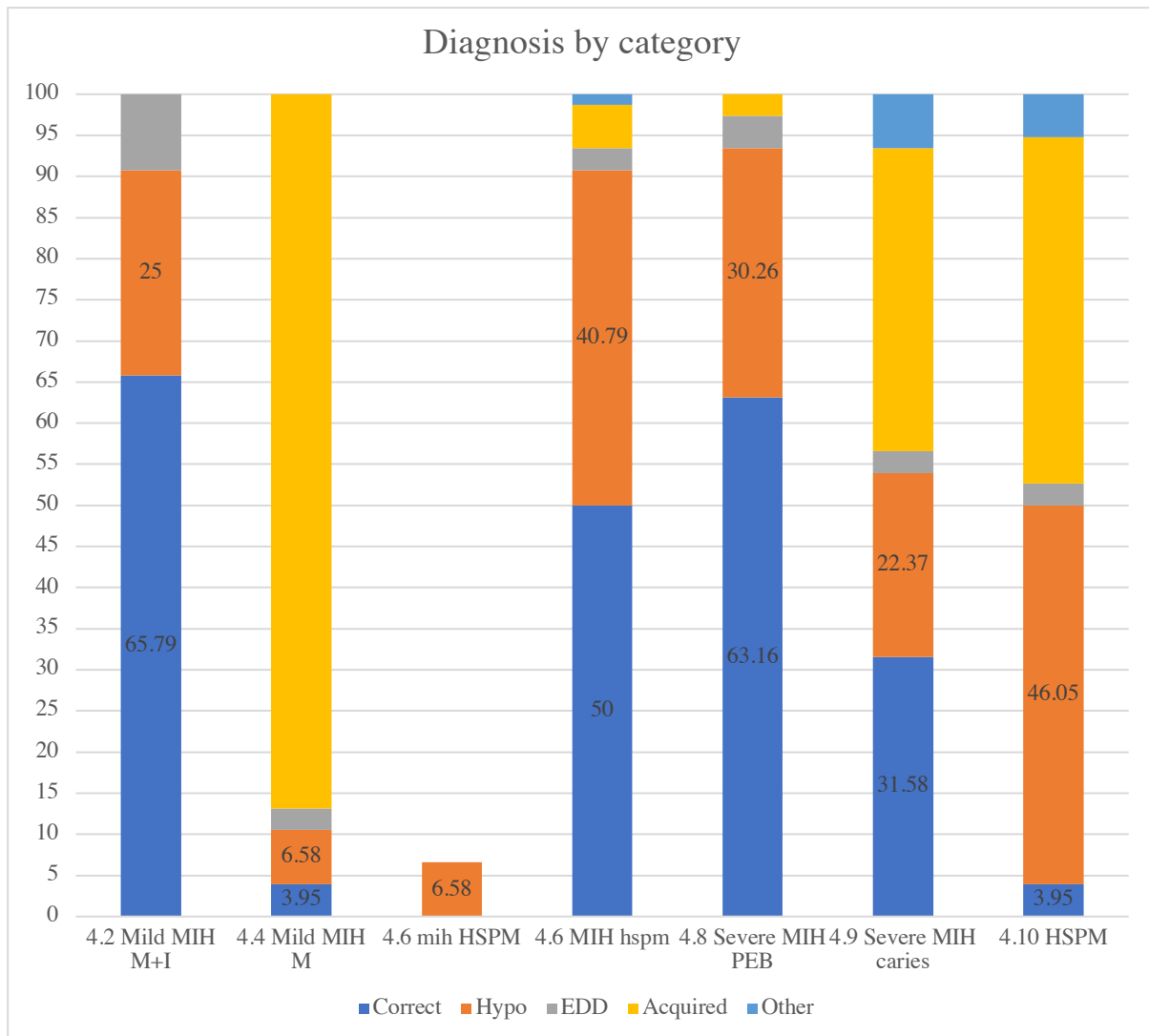
Figure 5. Diagnosis by categories for each case – *4.6 MIHhspm are results related to diagnosis of MIH in permanent dentition and 4.6mihHSPM relates to diagnosis of HSPM in primary dentition in same patient*

Figure six shows the number of accurately diagnosed cases of MIH / HSPM by participants in relation to confidence in diagnosis. Only 57 GDPs answered this question. No participants accurately diagnosed all seven cases. 71.93% of GDPs felt confident or very confident when diagnosing MIH. The relationship between confidence in diagnosis and accurate diagnosis was significant (p=0.016). No significant difference in diagnostic skill was found between those with postgraduate qualifications and those without (p=0.703).

Number of Accurately Diagnosed Cases vs Reported Confidence in Diagnosis
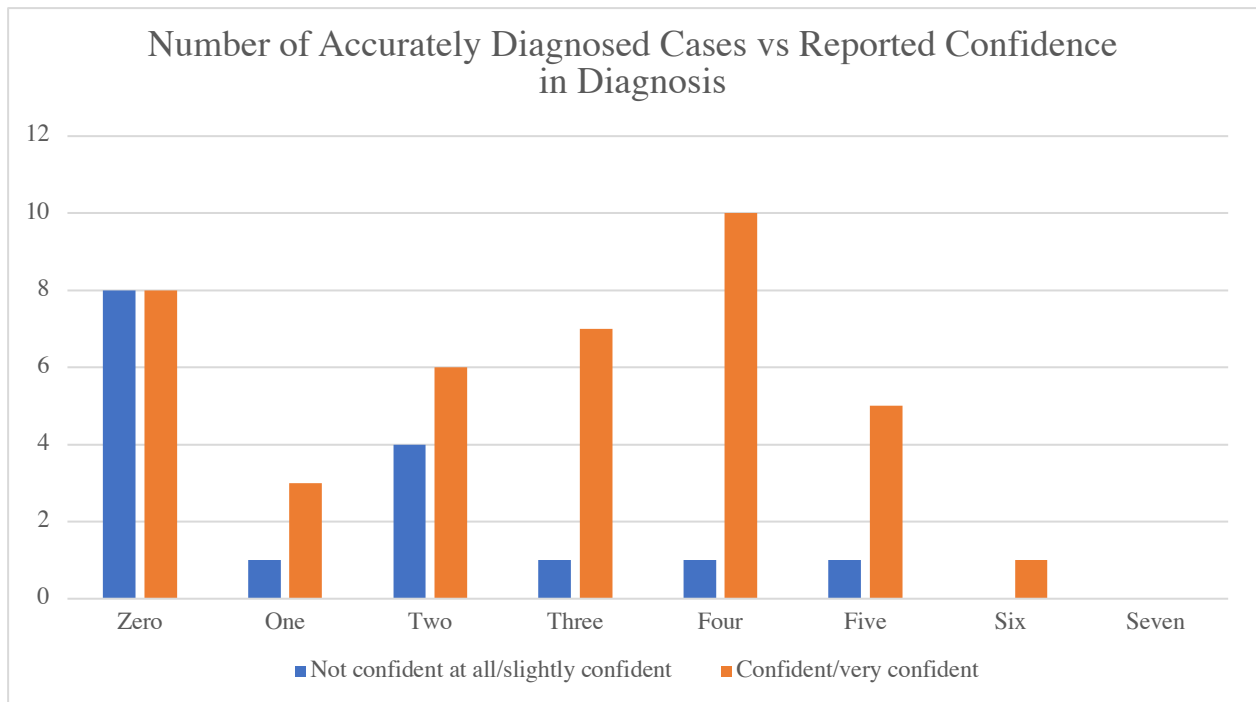
Figure 6. Number of participants accurately diagnosing cases in relation to self-reported confidence in diagnosis

Discussion

This is the first study to assess diagnosis of MIH by UK GDPs and demonstrates that diagnosis can be affected by the presenting features and severity of the condition.

An electronic survey was chosen as this gave the ability for quick dissemination. GDPR guidelines meant that restrictions existed on how participants could be contacted, reducing dissemination options. In comparison to the total population of GDPs within the UK, 81% work in England, 10% work in Scotland, 4% work in Northern Ireland and 4% in Wales[24], which was similar to the proportions of GDPs in this study.

Clinical photographs were selected using a rigorous process, and their accurate diagnosis confirmed by experienced clinicians. The use of clinical photographs to diagnose hypomineralisation and other enamel defects has been found to have a good sensitivity and specificity in comparison to clinical diagnosis .[25-27] The participants were unaware that the survey was investigating MIH, in order to recreate as closely as possible the normal diagnostic process during clinical examination.

This was the first study to assess how GDPs diagnose MIH when presented with vignettes, although Jalevik conducted a study to assess the difference between trained and untrained dentists in the detection of developmental defects of enamel (DDE). Their main findings were that the untrained staff tended to call all types of DDE hypoplasia and seemed to have limited knowledge to discern between different types of defect.[28] A recent publication in the UK reviewed strategies for distinguishing hypomineralisation from hypoplasia, confirming these are commonly confused conditions,[5] in agreement with our findings.

Other surveys have assessed treatment options for individual teeth with MIH. Kopperud et al disseminated their vignette survey to GDPs and specialists in Norway, investigating practices in tooth tissue removal when treating molars with MIH, alongside assessment of knowledge and experience of MIH.[21] Alanzi et al asked GDPs and specialists in Kuwait how they would manage individual teeth, alongside a traditional survey assessing knowledge, experience and confidence.[22] Neither studies assessed ability to diagnose MIH. Weerheijm and Megare asked members of the European Association of Paediatric Dentistry if they were familiar with the appearance of a tooth with MIH, using photographs of FPM and incisor teeth, but did not ask

participants to give a diagnosis for the tooth.[29] Crombie et al used the same format in a survey of the Australian and New Zealand Society of Paediatric Dentistry.[30]

Correct diagnosis of HSPM was much lower than for MIH, indicating that GDPs are not as familiar with the condition affecting primary teeth. It may also be true that many GDPs are not aware of the correct terminology to describe the condition in primary teeth. Where the cases demonstrated caries (Mild MIH (caries in primary teeth) and severe MIH with caries), accurate diagnosis was also lower. It may be that GDPs are better trained to detect caries, and find it difficult to identify MIH on a tooth which is also carious, or simply that the caries was clearer in these photographs.

The qualitative analysis of incorrect answers were across a spectrum, with some answers closer to the correct diagnosis than others. For example, description-based answers such as hypomineralisation, or condition-based answers such as molar-incisor-hypoplasia, demonstrate some awareness of hypomineralisation and hypoplasia (which can be confused with post-eruptive breakdown). Within the enamel developmental defects group, diagnoses that are often confused with MIH were recorded, such as fluorosis. The acquired defects group included common dental disease such as caries and tooth wear, which may have occurred alongside MIH but have a different appearance. Finally, the 'other diagnoses' theme included diagnoses such as orthodontic index of treatment need. Where fewer clinicians gave a diagnosis under the hypoplasia / hypomineralisation theme, this indicates that diagnosis was more challenging.

Over the last decade surveys to assess the experience of both paediatric specialists and GDPs in treating children with MIH have taken place, in Europe, Kuwait, the Middle East, Australisa and South Amercia.[18 19 23 30] The results have found that in general only half of GDPs surveyed are confident in the diagnosis of MIH. The only exception was in a study by Gambetta-Tessini et al, where over 80% of clinicians in both Chile and Australia reported confidence in diagnosis.[20] Crombie et al found that 98.3% of GDPs recognised the appearance of MIH teeth, but were not asked to diagnose the condition.[30] A survey from 2016 in the UK found that 57% of the 31 GDPs attending a study day on paediatric dentistry felt confident or very confident when diagnosing MIH.[18] Our findings are in keeping results from across the world but show an increase in confidence in the UK, with 71.93% of GDPs feeling confident or very confident when diagnosing MIH. Accurate diagnosis was found to be significantly related to confidence within this sample, however presence of postgraduate qualifications was not related to accurate diagnosis. Education at postgraduate and undergraduate level should focus on equipping clinicians with the skills to differentiate between different severities of MIH, hypoplasia and caries.

There are several limitations to the findings of this study. As the survey was shared on social media, an accurate response rate could not be estimated as the number of dentists who saw the survey is unknown. It is likely that the real response rate is low. As with any survey, only the most interested clinicians will complete it, leading to potential response bias. Most clinicians graduated in the last 20 years, and therefore the results cannot be extrapolated to more experienced GDPs. The results probably reflect those clinicians who are most interested in the care of paediatric dental patients, and the true results for GDPs across the UK may be different to the results found in this study. The small sample size also limits the application of findings more generally.

Conclusions

GDPs are able to accurately diagnose MIH best when both incisors and molars are affected, and no caries is present on either affected or unaffected teeth. Diagnosis of HSPM was challenging for GDPs. Hypoplasia is incorrectly used to describe hypomineralisation frequently. Confidence in diagnosis is significantly related to actual accuracy. The influence of diagnostic ability on treatment planning will be explored in the second paper of this series.

Declarations of Interests

None to declare

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Figures & Tables

Words including tables and figures - 2991

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