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"50 years of progress in paediatric dentistry"

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Abstract

Progress in paediatric dentistry over the last half a century has been evident across all areas of the speciality. This article highlights significant changes in the diagnosis, prevention and management of dental caries, traumatic dental injuries, developmental enamel defects, tooth erosion, dental fear and anxiety and safeguarding children. The dedication of clinicians and researchers along with advances in material science and technology have supported this progress. We discuss the importance of working with those both within and outside of the specialty in order to collaborate to improve children's oral health. There have been significant strides in the provision of child-centred holistic care and research. Reviewing the advancements made over this period has set a high precedent for making further progress within paediatric dentistry over the next 50 years.

Introduction

There have been many significant changes within the specialty of paediatric dentistry practice over the last half century, following the first issue of Dental Update. These advances are too numerous to discuss in just one article, so here we will present what we consider to be the key advancements within our field.

Prevention and management of caries

Not surprisingly, the management of caries, especially for younger children, has benefitted from considerable advances in our understanding of the disease process and its impact over the past 50 years. Although fluoridated toothpaste was first marketed in the U.K. before the launch of Dental Update, its pivotal role in reducing caries prevalence in our population has been widely disseminated through the Journal's publications.[1,2]

Another fluoride-containing product, fluoride varnish, has changed the face of dental practice-based prevention. Although first available in 1964, its use became much more widespread during the 1980s. This highly effective and simple intervention superseded other forms of topical fluoride such as acidulated phosphate fluoride gel.[3] The inclusion of fluoride varnishes in national guidance documents from the Scottish Clinical Effectiveness Programme and from Public Health England in the early 2000s, and monitoring of submitted claims data, likely furthered its adoption.[4-7] Furthermore, its use in community-based prevention schemes, such as 'Childsmile' has seen significant caries reduction within some of the most deprived and hard-to-reach child populations.[8] Another major contribution to caries prevention and management has been the modern resin-based fissure sealant, which was developed approximately 50 years ago.[9] All these interventions are now mainstays of national guidance on the prevention of caries.[6]

If we reflect on how we restore caries in our young patients, there has been a paradigm shift from Black's principles of radical caries removal and cavity preparation to a biological and far less destructive approach. This has been facilitated by advances in dental materials, particularly those with adhesive properties. One of the first steps along this road was the development of the sealant restoration.[10] Perversely, although less destructive as a technique, this may have led to over treatment, with dentists cutting teeth to investigate sound surfaces because of the fear of missing

caries. Fortunately, we have seen advances in the adoption of minimally interventive approaches, as our understanding of the carious process has evolved. Central to our modern practice is the knowledge that caries is driven by the biofilm on the tooth surface, together with greater understanding of the dentine-pulp complex's capacity to repair. The routine surgical investigation of a suspected carious lesion can no longer be justified, rather a 'sealing in' (and monitoring) approach is advocated for non-cavitated lesions. For more advanced lesions, sealing is also utilised as part of the practice of step-wise caries removal.[11,12]

Glass ionomer cements, which were invented in the early 1970s, have developed from a very difficult to manipulate material, with limited clinical use, to a material which can be used as a permanent restoration. The advent of resin-modified glass ionomer cements, alongside their fluoride-releasing properties, confer several advantages for use in children in the primary dentition.[13,14] The principle of sealing in caries has underpinned one of the most revolutionary changes in how we restore carious primary molars. Just over two decades ago, the non-invasive Hall technique was described for the placement of preformed metal crowns.[15] (Figure 1) This approach simply required the cementing of a preformed metal crown over a carious primary molar, without the need for local anaesthetic or caries removal.[15] Initial scepticism was counteracted by reported success rates of over 90% at 5-years; significantly better than outcomes achieved for teeth treated with intra-coronal restorations. In terms of other major changes to our choice of restorative materials, 2018 saw the restriction of amalgam use in children under the age of 15-years.[16] (Figure 2) Although amalgam had served us well, because of its many disadvantages, its loss is to be welcomed.

Figure 1: LRE and LLE treated with preformed metal crowns using the Hall Technique, the figure demonstrates fissure sealant restorations in LR6 and LL6, the LRD and LLD have been extracted.

Figure 2: Child in the mixed dentition, with the ULD restored with a disto-occlusal amalgam restoration.

However, despite significant advances in knowledge and techniques over the past five decades, we still find ourselves in a situation where dental disease and its consequences remain a significant problem, particularly for the most disadvantaged in our society.[17] In 2013, nearly a third (31 per cent) of 5-year-olds and nearly a half (46 per cent) of 8-year-olds had obvious decay experience in their

primary teeth. Overall, 58 per cent of 12-year-olds and 45 per cent of 15-year-olds reported that their daily life had been affected by problems with their teeth and mouth in the past three months.[18] The Care index, which albeit is a crude measure of operative care, remains very low at only 10.3% in 5-year-olds and continues to raise concern about the lack of restorative intervention in some primary care settings.[19]

Clearly, we still have a long way to go before we have consigned dental caries in children to history. This can only be achieved by a collaborative focus on prevention aimed at the reducing and eventually eliminating disparities in dental health.

Taking the 'trauma' out of traumatic dental injuries

Over the last 50 years, significant advances have been made in the understanding and treatment of different traumatic dental injuries (TDI). At the forefront of these developments has been Dr Jens Andreasen, who dedicated his career to furthering the field of dental traumatology.

There are a wide range of TDIs, involving both hard and soft tissues, and children may present with multiple different injury types following a severe impact. To help dental professionals in caring for this group, dental traumatology embraced good practice guidelines in the early 2000s, with the aim of identifying the best treatment options for different TDIs and taking the stage of dental development into account. Underpinning this guidance has been longitudinal cohort studies to quantify the outcomes from the treatment of different TDIs.[20,21] The improved understanding and quantification of prognosis for different injuries can be readily accessed using the bespoke tool available on the Dental Trauma website (https://dentaltraumaguide.org/free-version/?r=250&wcm_redirect_to=page&wcm_redirect_id=250). A key learning point from these TDI cohort studies is that often the injury itself determines the outcomes and that treatment for these injuries can be both beneficial or detrimental. Research in this area continues with the development of core datasets for researchers and clinicians which aim to encourage consistent collection of information.[22]

While dental professionals are well aware of the impact of TDI on children and their families, research has only recently started to collect and quantify the significant impacts that a TDI can have. The use of validated quality of life indices and qualitative research methods have begun to describe both short-

and longer-term impacts. The importance of the "voice of the child" and capturing impacts are a key priority for the future.[23]

The development of Cone-beam computed tomography systems (CBCT) has greatly enhanced diagnosis of the extent and nature of TDIs as well as identifying trauma-related sequelae such as root resorption. This imaging approach allows the 3D localisation of pathology, the extent of pathological lesions and improves understanding of root canal morphologies. However, the benefits of CBCT, especially in children, have to be weighed up against the increased radiation dose in comparison to conventional dental images.[24]

With improved understanding of how injured tissues respond following TDI, as well as developments in dental material science, there have been some significant advances in how TDIs are treated. Flexible splinting materials have been developed, such as titanium trauma splints, that allow efficient and simple placement, while allowing patients to keep gingival tissues clean.[25] (Figure 3) They also allow physiological tooth movement which promotes improved healing compared to the use of more rigid earlier materials.

Figure 3: Child in the mixed dentition with UR2 UR1 UL1 ULD splinted with a titanium trauma splint.

The advent of bio-ceramic materials such as mineral trioxide aggregate (MTA) and Biodentine (Septodont, Saint-Maur-des-Fossés, France)have brought considerable benefits to the endodontic management of non-vital immature permanent incisors in our young patients. Traditionally, the aim of treatment was to try to achieve apical barrier formation (apexification) through the long-term use of non-setting calcium hydroxide; which generally had a poor long-term outcome. In contrast, MTA has been found to provide consistent, efficient and effective root treatment for immature non vital and infected incisors. (Figure 4) These teeth have a considerably lower risk of crown/root fracture and the child requires far fewer treatment visits when compared with calcium hydroxide apexification.[26] The application of tissue engineering techniques to encourage continued root growth in immature non- vital and infected incisors is also an area of ongoing interest. However evidence in the field is still inconsistent, potentially owing to the damage caused not only to the pulp but also to the root surface complex.[26]

Figure 4: Radiograph of UR2 and UR1 treated with MTA to create an apical barrier, followed by thermal obturation.

Developments in developmental enamel defects

It is hard to imagine that 50 years ago our specialty had not heard the term 'molar incisor hypomineralisation' (MIH). This developmental enamel condition, affecting around 13% of children globally, has now become one of the most common reasons for children to be referred to specialist paediatric dentistry services.[27] The diagnostic criteria for MIH were first proposed in the early 2000s and describe hypomineralisation of one or more first permanent molars, often in association with hypomineralisation of some of the permanent incisors.[28]Affected teeth essentially have areas of poor enamel quality, which is discoloured porous, soft, displays poor bonding properties, and is prone to caries and post-eruptive breakdown.[29] Teeth may have a variety of white, cream, yellow or brown opacities, which may be of considerable cosmetic concern to the child and their family. In addition, affected molars can be exquisitely sensitive to normally innocuous thermal and mechanical stimuli, restricting normal oral functions such as eating and toothbrushing. Although a wealth of basic science and clinical research has been undertaken, the exact aetiology remains somewhat unclear, but is likely to involve both environmental and genetic factors.[30]

Regrettably, in our current era of social media overload, children may now be exposed to more appearance-related bullying than they were in the past. Children with visible incisor opacities may experience a host of negative social and emotional impacts, due to the way their teeth look, and frequently seek dental interventions. One of the challenges we then face is meeting children's expectations of 'removing' incisor opacities whilst still preserving tooth tissue. Since the 1980s, the use of microabrasion has been widely adopted as an effective and minimally invasive approach for reducing the visibility of brown incisor opacities.[31]However, this approach is less effective for white/cream opacities. Therefore, a welcome, and relatively recent, addition to our armamentarium has been the use of resin infiltration; the most widely used system being Icon™ (DMG, Hamburg, Germany). The theory being that the low viscosity resin infills the porous subsurface enamel, altering its refraction index to one that is closer to that of normal enamel, thus effectively 'hiding' the white colouration of the opacity. This technique has shown some promising, but not always predictable,

results.[31](Figure 5) However, a number of studies have demonstrated that even simple 'cosmetic' interventions can greatly improve how children feel about themselves.[32]

Figure 5: Pre- and post-treatment photos of a 9-year-old girl with discrete areas of hypomineralisation on her permanent central incisors. Use of resin infiltration (Icon™) was effective in reducing the visibility of these opacities.

If we look to the wider literature on developmental enamel defects, knowledge on the inherited condition, amelogenesis imperfecta (AI), has unquestionably seen the most significant advances. Since the identification, in 1991, of the first gene mutation to cause AI (located in AMELX), an astounding number of other novel gene mutations have also been implicated in non-syndromic types of AI.[33] Of particular clinical relevance, is the finding that some patients with a mutation in the FAM20A gene not only have AI (a hypoplastic phenotype) but also have nephrocalcinosis, known as enamel renal syndrome, which warrants an expedient urology referral.[34]The translation of this emerging genetic knowledge to everyday paediatric dentistry practice, is, however, still in its infancy. Although there is now the opportunity to incorporate genetic testing for AI (using the '21-gene AI panel test') within our practice, to aid more accurate classification and support patient understanding, there are some attitudinal, economic and competency barriers to overcome.[35]

Greater insights into children's dental fear and anxiety

As this article has highlighted, there have been significant achievements in the practice of paediatric dentistry during the last 50 years. However, something that has not changed, is that many children still suffer fear and anxiety with dental visits. The evidence is that dental fear and anxiety (DFA) is common, with a prevalence of 25% of children globally.[36] Unfortunately, DFA still creates significant barriers for children to have appropriate dental care.[37-39] Consequently, children with DFA are not as likely to benefit from the advances in the prevention, diagnosis, and treatment of dental caries now available.[40]

During the last 50 years, DFA in children has been managed through the use of behaviour management strategies, such as 'tell-show-do', which is well-accepted, but has little evidence to support its effectiveness; or children have been referred to specialist services for pharmacological interventions.[41-43] However, there is evidence that if childhood DFA is not addressed, it can become a

long-term condition, and persist into adult life.[44] Recently, researchers have recommended that dental professionals adopt a stepped treatment approach based on psychological techniques for children and adults who are concerned about dental care.[45,46] The overriding principle is that everyone can experience DFA, and that there are elements of the dental visit that can be changed to make dental care a more comfortable experience for all patients.[45,46]Additionally, the development of a self-help Cognitive Behavioural Therapy intervention ('Your teeth, you are in control') for children with DFA aged 9- to 16-years has shown promising results, and it currently being evaluated in a randomised controlled trial in primary dental care.[47] The use of virtual reality has also demonstrated potential for DFA.[48,49]

Tooth erosion

Attention to tooth erosion as an issue within paediatric dentistry received greater scrutiny with it's inclusion in the Child Dental Health Survey.[50] Tooth wear is seen across the age groups from 5-15, and rates have been increasing, perhaps owing to the consumption of highly acidic beverages.[50] Research has suggested links between dietary practice, gastro-oesophageal reflux and socio-economic status.[50] Erosion in children, including the primary dentition, can be recorded through the Basic erosion wear index.[51] Recommendations for the investigation, prevention and management of tooth erosion in children and young people is provided by the recently updated Faculty of Dental Surgery's 2021 guidelines.[52]

Safeguarding children

The dental team's role in safeguarding children from maltreatment is an area of practice that has changed dramatically in the past two decades, evidenced by rising referrals from paediatric dentistry to children's social care.[53]

Children have a right to protection from all forms of abuse and neglect and the dental team is obliged under statutory and ethical guidance to report any concerns to the authorities.[54-56] However, diagnostic and organisational challenges and lack of support led in the past to dental professionals' reluctance to be involved.[57]

Physical, emotional and sexual abuse and neglect all present in child dental patients.[58,59] However, dental neglect is now recognised as by far the commonest reason for dental professionals to refer

children and families to social services for assessment.[60-62] With one study estimating worldwide prevalence at 34% to 54%, dentistry has a key role in both its diagnosis and management.[63,64] Furthermore dental neglect is also a concern to both non-dental healthcare professionals and to parents.[65]

Accepted good practice is that certain vulnerable groups benefit from designated dental care pathways and missed dental appointments must be viewed as the child 'was not brought', placing their needs centre-stage.[66-68] Myriad other factors are now recognised as profoundly affecting children's wellbeing, including domestic violence, parental substance abuse and mental illness, sexual exploitation and trafficking. Over the past two decades, the development of tools including the 'Child Protection and the Dental Team' document, and the 'Was Not Brought' pathway provide valuable guidance to support dental professionals when safeguarding vulnerable children.[69,70]

Without doubt, in the past 50 years, paediatric dentistry has increased its contribution to safeguarding and promoting children's overall wellbeing, well above and beyond oral health.

Collaborative working

Progress in all the areas described, has only been possible through effective interdisciplinary collaborations between dental health professionals and researchers from different specialties and environments. However, considering public health issues that pervade oral health, there is only so much that can be achieved if dentists only work with dentists. There is now real recognition that for us to see real progress in children's oral health we need to address the wider determinants of health and influence a broader audience; health visitors, paediatricians, school nurses, social workers and local authority partners. Nationally, there was a call to "put the mouth back in the body" from the Chief Dental Officer, supported by the British Society of Paediatric Dentistry (BSPD) championing the fact that "Children's oral health is everybody's business".[71,72] BSPD's Dental Check by One and Mini Mouth Care Matters programmes began asking non-dental healthcare professionals to "Lift the lip" and engage in children's oral health.[73,74] These ideas weren't new but they effectively embraced social media to inform, engage and influence. Crucial to the move to place-based commissioning was the publication of the Commissioning Standard for Paediatric Dentistry in 2018 which led to the development of Managed Clinical Networks for Paediatric Dentistry. Over the next five years, these networks of key stakeholders developed to provide clinical leadership across England. (Figure 6) As

Integrated Care Systems assume their statutory responsibility in 2023, the Managed Clinical Networks should play an increasingly vital role in advocating for children's oral health, particularly with the publication of NHS England's CORE20PLUS5 approach to reducing health inequalities in children and young people.[75,76]

Figure 6 : Distribution of Managed Clinical Networks in paediatric dentistry over time

Dentists have long come together to support child oral health, the British Society of Paediatric Dentistry is an internationally recognised society and has been an advocate over the past six decades.[77] In the previous 50 years the group has achieved significant impact, through working with government, bringing together those within the speciality and across disciplines including medical specialities. This has been to highlight child oral health nationally as an issue, along with supporting and developing solutions to improve child oral health. The Society has patient-focussed resources to provide information directly to children and their carers, utilising many formats including social media, popular children's programmes and media personalities to support good oral health through an engaging format for children and their parents.

Child-centred dentistry

The ultimate aim of paediatric dentistry is to provide all children with evidence-based and high-quality care whilst fostering a lifelong positive attitude to dentistry. Over the past 50 years there has been an increasing onus to adopt a child-centred approach not only within clinical care but also in health research.[78,79] It is therefore encouraging to see reports of more widespread engagement of children as active participants within dental research. Further progress is welcome and vital to ensure that the care we provide over the next 50 years is child-focussed to address their needs as new technologies and treatments develop and require evaluation.

Conclusion

Hopefully, this brief summary has demonstrated some of the areas of significant progress made within the specialty of paediatric dentistry since the first publication of Dental Update 50 years ago. Change in attitudes, knowledge and practice have all led to measurable improvements in clinical- and patient-reported outcomes for children. However, there can be no room for complacency, so we continue to strive for further advances over the next half century.

Figures

Figure 1: LRE and LLE treated with preformed metal crowns using the Hall Technique, the figure demonstrates fissure sealant restorations in LR6 and LL6, the LRD and LLD have been extracted.

Figure 2: Child in the mixed dentition, with the ULD restored with a disto-occlusal amalgam restoration.

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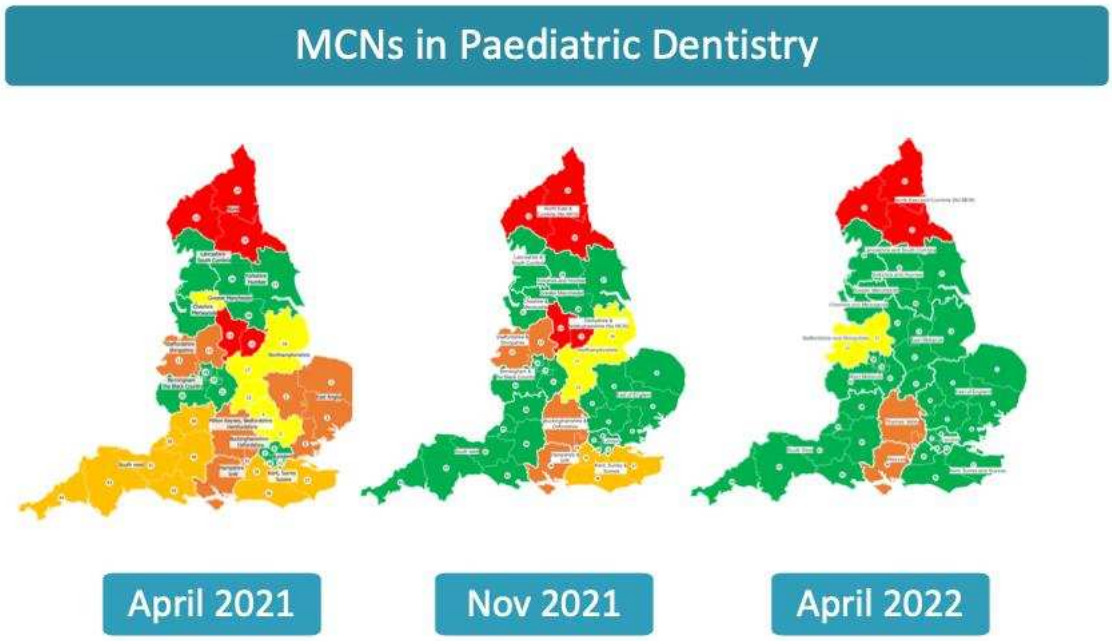
Figure 6 : Distribution of Managed Clinical Networks in dentistry over time



Green – dedicated and funded

Yellow – dedicated, unfunded

Light orange – Funded, shared

Dark orange – Unfunded, shared

Red – No MCN

References

1. Marinho VC, Higgins JP, Sheiham A, Logan S. Fluoride toothpastes for preventing dental caries in children and adolescents. Cochrane Database Syst Rev. 2003;2003(1):Cd002278.

2. Chestnutt IG. Addressing oral health inequalities in the United Kingdom – the impact of devolution on population-based fluoride policy. British Dental Journal. 2013;215(1):11-2.

3. Hawkins R, Locker D, Noble J, Kay EJ. Prevention. Part 7: Professionally applied topical fluorides for caries prevention. British Dental Journal. 2003;195(6):313-7.

4. Godson JH, Gallagher JE. Editorial - Delivering Better Oral Health 2021 - What's new and where next? Community Dent Health. 2021;38(4):224-5.

5. Brown N, Northover R, Harford S, Power R. NHS general dental practitioner claims in the South West for provision of topical fluoride, fissure sealants, radiographs, fillings and extractions for children born in 2009: an analysis of a five-year period. Br Dent J. 2022.

6. NHS England. Delivering better oral health: an evidence-based toolkit for prevention. London: NHS England 2021.

7. Scottish Dental Clinical Effectiveness Programme. Prevention and Management of Dental Caries in Children 2nd Edition. 2010 [cited 2022. Available from: https://www.sdcep.org.uk/wp-content/uploads/2018/05/SDCEP-Prevention-and-Management-of-Dental-Caries-in-Children-2nd-Edition.pdf.

8. McMahon AD, Wright W, Anopa Y, McIntosh E, Turner S, Conway DI, et al. Fluoride Varnish in Nursery Schools: A Randomised Controlled Trial - Protecting Teeth @3. Caries Res. 2020;54(3):274-82.

9. Rock WP. Fissure sealants. Results obtained with two different bis-GMA type sealants after one year. British Dental Journal. 1973;134(5):193-6.

10. Simonsen RJ, Stallard RE. Sealant-restorations utilizing a diluted filled composite resin: one year results. Quintessence Int Dent Dig. 1977;8(6):77-84.

11. Banerjee A. Minimal intervention dentistry: part 7. Minimally invasive operative caries management: rationale and techniques. Br Dent J. 2013;214(3):107-11.

12. Deery C. Caries detection and diagnosis, sealants and management of the possibly carious fissure. Br Dent J. 2013;214(11):551-7.

13. McLean JW, Wilson AD. Fissure sealing and filling with an adhesive glass-ionomer cement. Br Dent J. 1974;136(7):269-76.

14. Wilson AD, Kent BE. The glass-ionomer cement, a new translucent dental filling material. Journal of Applied Chemistry and Biotechnology. 1971;21(11):313-.

15. Innes NPT, Evans DJP, Stirrups DR. Sealing Caries in Primary Molars:Randomized Control Trial, 5-year Results. Journal of Dental Research. 2011;90(12):1405-10.

16. Regulation (EU) 2017/852 of the European Parliament and of the Council Article 10
Dental amalgam, (2017).

17. Public Health England. Inequalities in oral health in England. In: England PH, editor. London2021.

18. NHS Digital. Child Dental Health Survey 2013, England, Wales and Northern Ireland. In: Centre HaSCI, editor. London: NHS Digital 2015.

19. Public Health England. National Dental Epidemiology Programme for England: oral health survey of 5-year-olds 2019
A report on the variations in prevalence and severity of dental decay. In: England PH, editor. London2020.

20. Bourguignon C, Cohenca N, Lauridsen E, Flores MT, O'Connell AC, Day PF, et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 1. Fractures and luxations. Dental Traumatology. 2020;36(4):314-30.

21. Fouad AF, Abbott PV, Tsilingaridis G, Cohenca N, Lauridsen E, Bourguignon C, et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. Dental Traumatology. 2020;36(4):331-42.

22. Kenny KP, Day PF, Sharif MO, Parashos P, Lauridsen E, Feldens CA, et al. What are the important outcomes in traumatic dental injuries? An international approach to the development of a core outcome set. Dent Traumatol. 2018;34(1):4-11.

23. Wallace A, Rogers HJ, Zaitoun H, Rodd HD, Gilchrist F, Marshman Z. Traumatic dental injury research: on children or with children? Dental Traumatology. 2017;33(3):153-9.

24. Campbell F, Timms L, Deery C, Drage N. Cone beam computed tomography (CBCT) in paediatric dentistry. Dental Update. 2022;49(2):153-8.

25. Von Arx T, Filippi A, Lussi A. Comparison of a new dental trauma splint device (TTS) with three commonly used splinting techniques. Dental Traumatology. 2001;17(6):266-74.

26. Duggal M, Tong HJ, Al-Ansary M, Twati W, Day P, Nazzal H. Interventions for the endodontic management of non-vital traumatised immature permanent anterior teeth in children and adolescents: a systematic review of the evidence and guidelines of the European Academy of Paediatric Dentistry. European Archives of Paediatric Dentistry. 2017;18(3):139-51.

27. Schwendicke F, Elhennawy K, Reda S, Bekes K, Manton DJ, Krois J. Global burden of molar incisor hypomineralization. Journal of Dentistry. 2018;68:10-8.

28. Weerheijm KL, Duggal M, Mejàre I, Papagiannoulis L, Koch G, Martens LC, et al. Judgement criteria for molar incisor hypomineralisation (MIH) in epidemiologic studies: a summary of the European meeting on MIH held in Athens, 2003. Eur J Paediatr Dent. 2003;4(3):110-3.

29. Rodd HD, Graham A, Tajmehr N, Timms L, Hasmun N. Molar Incisor Hypomineralisation: Current Knowledge and Practice. International Dental Journal. 2021;71(4):285-91.

30. Garot E, Rouas P, Somani C, Taylor GD, Wong F, Lygidakis NA. An update of the aetiological factors involved in molar incisor hypomineralisation (MIH): a systematic review and meta-analysis. European Archives of Paediatric Dentistry. 2022;23(1):23-38.

31. Somani C, Taylor GD, Garot E, Rouas P, Lygidakis NA, Wong FSL. An update of treatment modalities in children and adolescents with teeth affected by molar incisor hypomineralisation (MIH): a systematic review. European Archives of Paediatric Dentistry. 2022;23(1):39-64.

32. Hasmun N, Vettore MV, Lawson JA, Elcock C, Zaitoun H, Rodd HD. Determinants of children's oral health-related quality of life following aesthetic treatment of enamel opacities. Journal of Dentistry. 2020;98:103372.

33. Smith CEL, Poulter JA, Antanaviciute A, Kirkham J, Brookes SJ, Inglehearn CF, et al. Amelogenesis Imperfecta; Genes, Proteins, and Pathways. Front Physiol. 2017;8:435.

34. Hassib NF, Shoeib MA, ElSadek HA, Wali ME, Mostafa MI, Abdel-Hamid MS. Two new families with enamel renal syndrome: A novel FAM20A gene mutation and review of literature. Eur J Med Genet. 2020;63(11):104045.

35. McDowall F, Kenny K, Mighell AJ, Balmer RC. Genetic testing for amelogenesis imperfecta: knowledge and attitudes of paediatric dentists. Br Dent J. 2018;225(4):335-9.

36. Grisolia BM, dos Santos APP, Dhyppolito IM, Buchanan H, Hill K, Oliveira BH. Prevalence of dental anxiety in children and adolescents globally: A systematic review with meta-analyses. International Journal of Paediatric Dentistry. 2021;31(2):168-83.

37. Morgan AG, Rodd HD, Porritt JM, Baker SR, Creswell C, Newton T, et al. Children's experiences of dental anxiety. International Journal of Paediatric Dentistry. 2017;27(2):87-97.

38. Wogelius P, Poulsen S. Associations between dental anxiety, dental treatment due to toothache, and missed dental appointments among six to eight-year-old Danish children: a cross-sectional study. Acta Odontol Scand. 2005;63(3):179-82.

39. Humphris GM, Zhou Y. Prediction of nursery school-aged children who refuse fluoride varnish administration in a community setting: a Childsmile investigation. International Journal of Paediatric Dentistry. 2014;24(4):245-51.

40. Seligman LD, Hovey JD, Chacon K, Ollendick TH. Dental anxiety: An understudied problem in youth. Clin Psychol Rev. 2017;55:25-40.

41. Buchanan H, Niven N. Self-report treatment techniques used by dentists to treat dentally anxious children: a preliminary investigation. Int J Paediatr Dent. 2003;13(1):9-12.

42. Coxon JD, Hosey MT, Newton JT. The impact of dental anxiety on the oral health of children aged 5 and 8 years: a regression analysis of the Child Dental Health Survey 2013. Br Dent J. 2019;227(9):818-22.

43. Armfield JM, Heaton LJ. Management of fear and anxiety in the dental clinic: a review. Aust Dent J. 2013;58(4):390-407; quiz 531.

44. Thomson WM, Broadbent JM, Locker D, Poulton R. Trajectories of dental anxiety in a birth cohort. Community Dent Oral Epidemiol. 2009;37(3):209-19.

45. Newton T, Asimakopoulou K, Daly B, Scambler S, Scott S. The management of dental anxiety: time for a sense of proportion? Br Dent J. 2012;213(6):271-4.

46. Hare J, Bruj-Milasan G, Newton T. An Overview of Dental Anxiety and the Non-Pharmacological Management of Dental Anxiety. Primary Dental Journal. 2018;7(4):36-9.

47. Marshman Z, Rodd H, Fairhurst C, Porritt J, Dawett B, Day P, et al. The CALM trial protocol: a randomised controlled trial of a guided self-help cognitive behavioural therapy intervention to reduce dental anxiety in children. Trials. 2023;24(1):15.

48. Lahti S, Suominen A, Freeman R, Lähteenoja T, Humphris G. Virtual Reality Relaxation to Decrease Dental Anxiety: Immediate Effect Randomized Clinical Trial. JDR Clin Trans Res. 2020;5(4):312-8.

49. Asl Aminabadi N, Erfanparast L, Sohrabi A, Ghertasi Oskouei S, Naghili A. The Impact of Virtual Reality Distraction on Pain and Anxiety during Dental Treatment in 4-6 Year-Old Children: a Randomized Controlled Clinical Trial. J Dent Res Dent Clin Dent Prospects. 2012;6(4):117-24.

50. Nunn JH, Gordon PH, Morris AJ, Pine CM, Walker A. Dental erosion -- changing prevalence? A review of British National childrens' surveys. Int J Paediatr Dent. 2003;13(2):98-105.

51. Aránguiz V, Lara JS, Marró ML, O'Toole S, Ramírez V, Bartlett D. Recommendations and guidelines for dentists using the basic erosive wear examination index (BEWE). British Dental Journal. 2020;228(3):153-7.

52. Royal College of Surgeons of England. Faculty of Dental Surgery. Clinical guidelines for dental erosion

Diagnosis, prevention and management of dental erosion. London; 2021.

53. Harris JC, Baker SR, Elcock C. Paediatric dentists' role in child protection practice: Progress over time? Int J Paediatr Dent. 2022;32(5):714-23.

54. General Dental Council. Standards for the Dental Team 2013 [18.01.2023]. Available from: www.gdc-uk.org/standards-guidance/standards-and-guidance/standards-for-the-dental-team.

55. Government H. Working Together to Safeguard Children: a guide to inter-agency working to safeguard and promote the welfare of children. 2018.

56. United Nations High Commissioner for Human Rights. United Nations Convention on the Rights of the Child. Geneva, Switzerland: Office of the United Nations High Commissioner for Human Rights. 1989.

57. Welbury RR, MacAskill SG, Murphy JM, Evans DJ, Weightman KE, Jackson MC, et al. General dental practitioners' perception of their role within child protection: a qualitative study. Eur J Paediatr Dent. 2003;4(2):89-95.

58. Maguire S, Hunter B, Hunter L, Sibert JR, Mann M, Kemp AM. Diagnosing abuse: a systematic review of torn frenum and other intra-oral injuries. Arch Dis Child. 2007;92(12):1113-7.

59. Harris JC. The mouth and maltreatment: safeguarding issues in child dental health. Arch Dis Child. 2018;103(8):722-9.

60. Bhatia SK, Maguire SA, Chadwick BL, Hunter ML, Harris JC, Tempest V, et al. Characteristics of child dental neglect: a systematic review. J Dent. 2014;42(3):229-39.

61. Kvist T, Cocozza M, Annerbäck EM, Dahllöf G. Child maltreatment - prevalence and characteristics of mandatory reports from dental professionals to the social services. Int J Paediatr Dent. 2017;27(1):3-10.

62. Brattabø IV, Bjørknes R, Åstrøm AN. Reasons for reported suspicion of child maltreatment and responses from the child welfare - a cross-sectional study of Norwegian public dental health personnel. BMC Oral Health. 2018;18(1):29.

63. Harris JC, Balmer RC, Sidebotham PD. British Society of Paediatric Dentistry: a policy document on dental neglect in children. Int J Paediatr Dent 2009; 28: e14-e21. First published online: May 14 2009. doi: 10.1111/j.1365-263X.2009.00996.x

64. Khalid G, Metzner F, Pawils S. Prevalence of dental neglect and associated risk factors in children and adolescents-A systematic review. Int J Paediatr Dent. 2022;32(3):436-46.

65. Tuthill D, Guest-Rowlands G, Hingston EJ. When does childhood dental caries become neglect or abuse: do parents think what we think? Br Dent J. 2021.

66. Kirby J, Harris JC. Development and evaluation of a 'was not brought' pathway: a team approach to managing children's missed dental appointments. Br Dent J. 2019;227(4):291-7.

67. Park CM, Welbury R, Herbison J, Cairns A. Establishing comprehensive oral assessments for children with safeguarding concerns. Br Dent J. 2015;219(5):231-6.

68. Ridsdale L, Johnston L, James N, Balmer R. Looked after children: an overview for the dental team. Br Dent J. 2023;234(1):34-8.

69. British Dental Association. IMPLEMENTING 'Was Not Brought' in your practice 2020 [Available from: https://www.bda.org/advice/Documents/WNB-implementation-guide-AW.pdf.

70. Harris J, Sidebotham P, Welbury R with Townsend M, Green M, Goodwin J, Franklin C. Child Protection and the Dental Team: an introduction to safeguarding children in dental practice. 2006 (updated 2013). Sheffield: COPDEND.www.bda.org/childprotection

71. Hiscott S. Putting the mouth back in the body 2016 [Available from: https://dentistry.co.uk/2016/09/13/putting-the-mouth-back-in-the-body/.

72. Conference report: Why children's health is everyone's business. British Dental Journal. 2018;224(9):672-3.

73. Health Education England. About the Mini Mouth Care Matters programme 2023 [Available from: https://www.e-lfh.org.uk/programmes/mini-mouth-care-matters/.

74. British Society of Paediatric Dentistry. Dental Check by One: British Society of Paediatric Dentistry 2022 [Available from: https://www.bspd.co.uk/dental-check-by-one.

75. NHS England. What are integrated care systems? 2023 [18.01.2023]. Available from: https://www.england.nhs.uk/integratedcare/what-is-integrated-care/.

76. NHS England. Core20PLUS5 – An approach to reducing health inequalities for children and young people 2023 [Available from: https://www.england.nhs.uk/about/equality/equality-hub/national-healthcare-inequalities-improvement-programme/core20plus5/core20plus5-cyp/.

77. British Society of Paediatric Dentistry. The History of BSPD 2023 [22.01.2023]. Available from: https://www.bspd.co.uk/About/Our-History.

78. Marshman Z, Gibson BJ, Owens J, Rodd HD, Mazey H, Baker SR, et al. Seen but not heard: a systematic review of the place of the child in 21st-century dental research. International Journal of Paediatric Dentistry. 2007;17(5):320-7.

79. Marshman Z, Gupta E, Baker SR, Robinson PG, Owens J, Rodd HD, et al. Seen and heard: towards child participation in dental research. International Journal of Paediatric Dentistry. 2015;25(5):375-82.