Commentary

Chalky teeth 100 years on

What comes next?

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One hundred years ago, the eminent medical scientist Bernhard Gottlieb described developmentally disrupted teeth as having "chalky enamel" and "chalky spots" that "crumble" easily.[1,2] Such evocative descriptors subsequently became research staples and a popular colloquialism ("chalky teeth") used by some dental practitioners.[3] Today, after easing various sticking points, The D3 Group (D3G) for developmental dental defects (D3s) is using chalky teeth to headline its international campaign for alleviating decay through medical prevention of "chalky molars" (molar hypomineralization [MH]).[4-7] MH, which affects the 2-year molars, 6-year molars, or both in 1 in 5 children worldwide and is causally linked to infantile illness, is well evidenced but poorly recognized as a principal risk factor for childhood decay.[8-10] The chalky enamel centenary coincides with 2 advances—a scientific breakthrough and the inaugural D3 symposium—that create opportunities for improving global health.[11,12] But will the profession rally and grab the bull by its horns?

Gottlieb is considered the founder of biological thinking in dentistry, having instigated the field of oral histopathology during his medical training.[13] His 1920 investigation of rickets and other childhood diseases prompted questions about the pathogenesis of "enamel hypoplasia" that persist today—why are lesions scattered among normal enamel, and do they reflect cellular or extracellular disruption? He applied chalky descriptors to both immature enamel (as seen histologically) and erupted teeth, as back then "hypoplasia" embraced what today is known separately as hypoplasias (pits, grooves) and hypomineralized opacities.[1,2,14,15]

After decades of steady evolution of D3 science and allied use of the chalky metaphor, there was only partial uptake into dental practice. Enamel hypoplasia became 4 major D3s (hypoplasia, amelogenesis imperfecta, dental fluorosis, demarcated opacities) delineated by causation and pathogenesis.[15] Hypomineralized enamel in opacities was found to have elevated porosity and carbonate levels, rendering it more like chalk (calcium carbonate) and hence less resistant to acid. In addition to the major D3s, early decay (today's "white-spot lesion") was described as chalky, providing a scientifically legitimized but complex picture for practitioners to digest.[3] The literature reveals ongoing confusion over scientific differences among hypoplasia, hypomineralization, and posteruptive breakdown, some of which hold immediate clinical significance.[14] Moreover, focus on molar-incisor hypomineralization, a common clinical presentation of demarcated opacities involving 6-year molars, contradicts the scientific perspective of a pathologic continuum across all teeth.[6,7] Of greater concern, despite repeated evidencing since 1949, the predominant role of chalky opacities in childhood decay lacks frontline recognition across research, clinical, and public health domains.[6,7,10]

Popular language soon adopted the use of "chalky teeth," and the ensuing terminological laxity prompted tensions for dentists and laypeople alike. Interviews of elderly New Zealanders who had lost all their teeth at young ages revealed the concept of being born with some decay-prone chalky teeth (that is, today's MH) arose early, with 1 respondent lucidly attributing this diagnosis to a dental school professor in 1948. In 2011, a US professor publicly dubbed MH as chalky teeth, and other chalk analogies were popularized during the 1970s.[3] While founding D3G, I learned that some dentists resented the terms chalky or soft teeth, citing inappropriate use by patients when the real problem was dental plaque (not D3s). Conversely, savvy parents were rightly upset to be blamed by MH-unaware dentists for rapid decay in just 1 or 2 of a child's molars (distinctively, MH has a sporadic phenotype).[6-8] Such frictions are attributable to inadequacies in science translation.

D3G was formed in 2007, recognizing both a global need for translating D3 science beyond dental practice, and a chalky teeth problem consisting of 3 levels—D3s themselves, education gaps,

and lack of scientific understanding. Now an international cross-sector network, the budding D3 movement seeks primarily to alleviate childhood decay and other burdens through the medical prevention of MH.[5-7] A public-facing Chalky Teeth Campaign was developed to advocate for research and provide family-friendly education via a storybook and D3G's online resource, which serves multiple audiences including practitioners wanting to manage hypoplasia and hypomineralization knowledgeably.[4,5,16] Central to this initiative is a translational terminology that guides MH-related conversations from chalky teeth through hypomineralized molars and demarcated opacities (chalky molars, chalky spots, chalky enamel) to microscopic detail such as porosity (missing tooth bricks).[14,17] Other frictions were resolved by aligning chalky teeth with the science (that is, D3s and early decay) and substituting today's disparate clinical designations for idiopathic opacity disorders ("molar-incisor hypomineralization," "hypomineralized primary second molar," and "deciduous molar hypomineralization") with the scientifically stronger concept of MH having a variable phenotype spanning all molar types plus any other teeth in the primary and permanent dentitions.[6-9] These clinico-scientific advances are being forward-translated to the public using internal and external outlets, whereas the public-facing elements are being reverse-translated to health care workers and researchers through the literature and the D3 symposium in Toronto, Ontario, Canada.[4,5,12,16,18]

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With translation established, research leading to the medical prevention of MH assumes primacy. The 100-year-old mystery about opacity localization remains key to understanding the pathogenesis of chalky enamel and hence MH.[6,19] Fortuitously in 2020, 2 reports from D3G's lead biomedical researchers show that, contrary to dogma about injured enamel cells, chalky opacities arise from localized exposure of immature enamel matrix to serum albumin.[11,20] These breakthrough findings herald a turning point for investigating causation and molecular diagnosis of MH. Reinforcing the importance of basic science, this discovery follows decades of investment in biochemistry and proteomics, just as pioneering histology underpinned Gottlieb's success.[13,21]

On balance, the past century has seen steady progress in D3 science—albeit slowed by marginalization—but only fragmentary translation into preventive health care. Today's D3 movement is poised to attack the chalky teeth problem, rapidly and comprehensively, under the catchphrase "Healthier Babies = Stronger Teeth."[22] Converting this global health opportunity into action will depend on securing a joint mandate from key stakeholders (researchers, educators, practitioners, industry, policy makers) and forming a collaborative plan for an implementation journey that to some may seem disruptive. Science translation is often facilitated by figurative language, and so readers are encouraged to join the chalky teeth journey by talking the talk ("Speak Chalky Teeth")[17] and walking the walk as befits their daily grind.[23] ■

https://doi.org/10.1016/j.adaj.2020.07.022

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Disclosure. Dr. Hubbard did not report any disclosures.

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