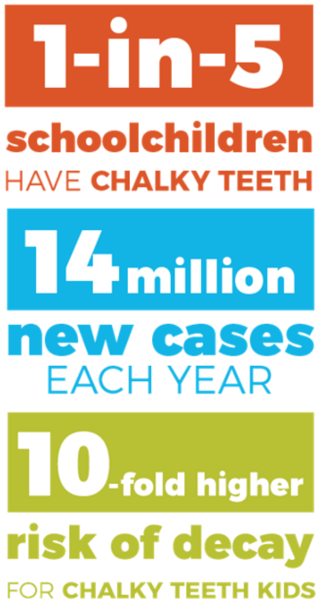
Mystery of children's 'chalky teeth' explained

A blood protein blocks hardening of enamel on teeth growing inside the jaw

Australian and Chilean researchers solve a 100-year-old mystery and call for education and research to save millions of teeth worldwide.

One in five children have chalky tooth enamel – visible as discoloured enamel spots – which often causes severe toothache and decay, and sometimes leads to abscesses, extractions and orthodontic problems.



Now, researchers from The D3 Group (based at The University of Melbourne, Australia) and the University of Talca in Chile, have discovered the mechanism causing molar hypomineralisation, the commonest type of chalky teeth.

They report today in *Frontiers of Physiology* that chalky molars arise when developing enamel is contaminated by albumin – a protein found both in blood and in the tissue fluid surrounding developing teeth. The trigger appears to be childhood illnesses.

"The result is a sort of 'mineralisation blockage', which is highly localised to the areas on individual teeth that become chalky enamel spots," says Mike Hubbard, a University of Melbourne research professor and lead author on the report.

"This discovery allows us to correct 40 years of medico-dental dogma which blamed defective enamel-forming cells. What this dogma couldn't explain is why chalkiness affects only one or a few teeth in a child's mouth."

The discovery

"We've shown instead that albumin leaks in occasionally at weak spots, binding to enamel-mineral crystals and blocking their growth. It's not a system-wide problem, but a very localised one."

The researchers suspect that the albumin leakage is triggered by routine baby illnesses such as a fever. Now they plan to:

1. Determine the specific underlying causes, such as environmental factors or pathogens
2. Promote their findings to dentists, other child health professionals and parents, so they can all be on the lookout for chalky teeth.

"We can't yet prevent chalky molars from developing in the first place, but if health professionals catch them early – when they first enter the mouth – then we dentists can usually save them," says Vidal Perez, a paediatric dentist and researcher at the University of Talca.

The impact of chalky teeth

"Many parents blame themselves, but they couldn't have prevented it," says Melbourne paediatric dentist Karen Kan. "Currently we can't prevent or cure chalky molars."

"For now, awareness is important. If you notice that something is different, if we can catch it early then we can start treatment and reduce the lifelong impact. It's exciting that we now know the mechanism. Hopefully that will lead one day to prevention."

Karen treated seven-year-old Antonio in March 2020. “He was only eating soft food. We thought he was vegetarian,” says Harri, his mum. Antonio has had five molars removed and now he loves steak. But he’s facing years of orthodontic work.

The back story

There are several types of chalky teeth reflecting different causes such as genetic anomalies and problems with nutrition.

The research team is particularly concerned about molar hypomineralisation as it carries the most social and economic impact. “Molars are particularly prone to damage,” says Vidal. "They are hidden away at the back of our mouths, with grooves that catch food, and they’re harder to clean.”

A tooth with severe hypomineralisation is 10 times more likely to decay than one without. It is very much a silent epidemic, causing lots of suffering.

The scale of the problem became apparent to Mike when he noted fluoridation of community water supplies led to a big but incomplete reduction of tooth decay in children. A substantial proportion of children with unexplained decay remained. So, he founded a research and education network, The D3 Group for developmental dental defects, to understand what was happening.

Fluoride, which protects against tooth decay in normal enamel, has little if any effect on chalky molars, which are as prevalent in developed countries as in developing ones.

Chalky tooth enamel was first studied by Austrian (and later, American) medical researcher Bernhard Gottlieb, who reported in 1920 the mystery that only some parts of some teeth are affected.

“Building on this research breakthrough, and with appropriate resourcing, The D3 Group can now look towards a medical strategy for preventing this worldwide problem,” said Mike.

“This new avenue of research could one day eliminate about half of childhood tooth decay, along with its disturbing costs to affected individuals and society,” he says.

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Images and links

- Antonio with his mum Harri
- A two-year molar with chalky brown enamel

Images and supporting information at www.scienceinpublic.com.au

More about The D3 Group: https://www.thed3group.org/mission-origins.html

Paper details

A breakthrough in understanding the pathogenesis of molar hypomineralisation: The mineralisation-poisoning model

Frontiers of Physiology: https://www.frontiersin.org/articles/10.3389/fphys.2021.802833/abstract

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Abstract

Popularly known as “chalky teeth”, molar hypomineralisation (MH) affects over 1-in-5 children worldwide, triggering massive amounts of suffering from toothache and rapid decay. MH stems from childhood illness and so offers a medical-prevention avenue for improving oral and paediatric health.

With a cross-sector translational research and education network (The D3 Group; thed3group.org) now highlighting this global health opportunity, aetiological understanding is urgently needed to enable better awareness, management and eventual prevention of MH. Causation and pathogenesis of “chalky enamel spots” (i.e., demarcated opacities, the defining pathology of MH) remain unclear despite 100 years of investigation.

However, recent biochemical studies provided a pathomechanistic breakthrough by explaining several hallmarks of chalky opacities for the first time. This article outlines these findings in context of previous understanding and provides a working model for future investigations.

The proposed pathomechanism, termed “mineralisation poisoning”, involves localised exposure of immature enamel to serum albumin. Albumin binds to enamel-mineral crystals and blocks their growth, leading to chalky opacities with distinct borders. Being centred on extracellular fluid rather than enamel-forming cells as held by dogma, this localising pathomechanism invokes a new type of connection with childhood illness.

These advances open a novel direction for research into pathogenesis and causation of MH, and offer prospects for better clinical management. Future research will require wide-ranging inputs that ideally should be coordinated through a worldwide translational network. We hope this breakthrough will ultimately lead to medical prevention of MH, prompting global health benefits including major reductions in childhood tooth decay.