EDITORIAL

Desensitizing Dentin: The Natural Way

Sampath Vidhya

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Dentin hypersensitivity (DH) is a painful clinical condition arising from exposure of the patent dentinal tubules to thermal, osmotic, chemical, tactile, or evaporative stimuli. Brännström's hydrodynamic theory supports the hypothesis that pain arises from the excitation of the nerve terminals at the pulp-dentin interface due to the disruption of fluid dynamics within the tubules.[1] The prevalence of DH is heterogeneous across studies owing to the diversity associated with data collection such as place of sampling, age, stimuli used, and measurement methods. Zeola et al. systematically reviewed the prevalence of DH in various populations and estimated it to be between 11.5 and 33.5%.[2]

Topical application of agents that either interrupt intra-dental nerve excitability or occlude dentinal tubules have remained the main strategies for treating DH. These active ingredients are incorporated into dentifrice formulation and marketed as desensitizing toothpastes which are easily available, economical, and convenient to use for patients. Toothpaste containing potassium, strontium, fluoride, arginine, bioactive glass and nanohydroxyapatite (nHA) are currently available. While these agents have proven their efficacy in several clinical studies, a consistent interest always exists in emerging calcium phosphate formulations as remedies for DH.[3]

Hydroxyapatite (HA) is a bioactive and bio-mimetic calcium phosphate mineral with structural and chemical similarity to bone and the inorganic component of natural teeth. It can be synthesized using hydrothermal processes, chemical precipitation methods, or biogenic sources. Nanometric-sized materials offer advantages over their micrometric counterparts as the former has smaller size, larger surface area, mechanical strength, and chemical reactivity.[4] Nanohydroxyapatite (nHA) is an indispensable remineralizing agent in preventive dentistry. Vano et al.[5] and Hu et al.[3] recommended nHA as the primary and the best choice of treatment for managing DH. When applied to exposed dentin, nHA obliterates the dentinal tubules by progressively plugging them and regenerates a mineralized surface layer that could prolong the desensitization effect.[5]

Recently, a growing interest in synthesizing nHA from natural sources has been evidenced in the dental literature. Biogenic sources as precursors yield environment-friendly HA with high crystallinity. Hydroxyapatite prepared from natural sources retains the original animal tissue architecture that enhances its bioactivity. It also contains Fe^{2+}, Mg^{2+}, Si^{2+}, Na^{+}, and F^{-} ions in its composition which are unattainable using chemical precursors. Egg shells of hen and duck, oyster shells, fish spines, and animal bones are the various natural sources from which nHA has been successfully synthesized.[6]

The earliest evidence showed that nHA synthesized from hen eggshell using the combustion method occluded patent dentinal tubules completely in extracted teeth.[7] Onwubu et al. obtained nearly round nHA particles with a diameter of 63 nm from eggshells using the wet chemical precipitation method. The composition of these nanoparticles was predominantly apatite (74.8%) and they were able to achieve 97.3 ± 2.23% of tubule occluded area when applied for 5 minutes on bovine dentin.[8] The nHA with a much smaller particle size of 9–21 nm was reportedly synthesized from eggshells using an environment-friendly mechanochemistry technique. These particles achieved complete remineralization of the dentinal tubules.[9] Yezdani et al. prepared calcium-deficient, rod-shaped nHA with a particle size of 30–40 nm from eggshells using microwave method. These particles deposited a dense surface layer and packed mineral deposits into the patent tubules more effectively compared to commercial products containing casein phosphopeptide-amorphous calcium phosphate (CPP-ACP), NovaMin or Pro-Argin®.[10]

A recent study showed that nHA particles obtained from fish scales were large (190 ± 81.8 nm) and irregular, with marginally higher HA content (77%) compared to smaller (11.6 ± 2.7 nm), rod-shaped eggshell-derived particles containing 74.8% HA. The smaller nanoparticles occluded patent tubules better than the larger ones (78.2 ± 1.5% vs 59.7 ± 1.7%).[11] The nHA was also synthesized from oyster shells using the precipitation method with an average crystal size of 31.93 ± 2.1 nm. The Ca/P ratio of these particles was 1.67, which is similar to the HA of a human tooth. These particles deposited a mineralized layer on dentin and achieved a significantly higher percentage of tubule occlusion (96.88%) compared to CPP-ACP (71.30%). The mineral deposits penetrated the dentinal tubules and were also resistant to acid challenge.[12]

Synthesis of nHA from natural sources is a feasible, economical, sustainable, and environmentally friendly process. Most of these precursors which are otherwise dumped as waste end up as a biological burden in the environment. Commercial utilization of these materials is an effective waste management strategy that addresses the circular economy and promotes a cleaner and greener environment. As the basic research with naturally sourced nHA is highly promising, it is time the dental fraternity invests larger interests in translating research from "bench to bedside" to foster

Department of Conservative Dentistry and Endodontics, SRM Dental College, Chennai, Tamil Nadu, India

Corresponding Author: Sampath Vidhya, Department of Conservative Dentistry and Endodontics, SRM Dental College, Chennai, Tamil Nadu, India, Phone: +91 9445563355, e-mail: vidhyas@srmist.edu.in

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patient care. Though the biocompatibility of eggshell and oyster shell-derived nHA has been proven by previous studies, elaborate insights are still needed regarding nanoparticle interaction with biological tissues.[9,12] Most of the above-mentioned studies have used the powder form of nHA under controlled laboratory conditions. While commercial toothpastes use 10–15% of nHA, it will be interesting to proportion, and formulate dentifrices with naturally sourced nHA and to investigate their effects in the dynamic oral environment in the form of clinical trials.

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