Nano Hydroxyapatite

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Key points

- Hydroxyapatite (HAp) is a biocompatible and stable calcium phosphate with low solubility
- Hydroxyapatite (HAp) is present largely in enamel
- Hydroxyapatite has similarities to bones
- HAp can also detect tumours as it is unique and has outstanding properties.

Abstract

The mineralized tissues of our body such as teeth and bone are composed of calcium phosphate, which plays an important role in hard tissue engineering as well as in regenerative procedures of these tissues. In dentistry, hydroxyapatite (HAp) is a biocompatible and stable calcium phosphate with low solubility. It is being used for various applications such as re-mineralization of teeth, to reduce teeth sensitivity, oral biofilm control, and whitening of teeth.

Mammalian hard tissues are majorly composed of Hydroxyapatite or Hap. It is chemically known as Calcium hydroxy phosphate (Ca10 (PO4)6 (OH) 2). It is also present in natural phosphate mineral rocks. Characteristics of hydroxyapatite such as biocompatibility, hydrophilicity, surface functional groups, acidity, basicity, porosity, etc. make it very useful for scientific purposes in medical, environmental remediation as well as industrial fields. It is also useful for dentists in implantology, surgery, periodontology, aesthetics, and prevention.1

Hydroxyapatite might be helpful to prevent dentine hypersensitivity, caries, and sensitivity after bleaching of teeth. Avian eggshell hydroxyapatite might be a filler material in bone regeneration during oral procedures.

Nano-HAp is a relatively novel material with excellent chemical, physical, mechanical, and biological properties due to which it is appropriate for multiple interventions. The goal of this discussion is to get a vast understanding of Nano hydroxyapatite as well as the promotion of nanomaterials used for treatment in dentistry.

Oral cavity and Hap

Hydroxyapatite (HAp) is present largely in enamel (mineralized part of teeth) which gives bright white colour to enamel. It closes the little pores of the enamel surface to eradicate the diffuse reflectivity of light.2 Therefore, it can whiten teeth, plays a very significant role in re-mineralization of enamel and dentine after caries (demineralization of inorganic portion of the tooth) and reduces the sensitivity of teeth.

Caries and Hap

One of the most common dental illnesses is caries. It leads to discomfort as well as damage. Its treatment is very costly. Causes of demineralization of dentine and enamel are fermentable carbohydrates, cariogenic bacteria as well as changes in pH of saliva.3 Caries destroy the occlusion of teeth. At recent times, a reduction in caries cases have been observed due to the preventive measures being taken. But initial caries is still continuously observed i.e., Lesions with less hydroxyapatite and more pore volume. Light scatters in a different way as compared to sound enamel and lesions appear opaque known as initial caries or white spots. For re-mineralization of the initial caries lesions, application of fluoride-containing agents, calcium phosphate containing pastes bioactive glasses, self-assembling peptides and most importantly synthetic zinc-carbonate-hydroxyapatite Nanocrystals is useful which have same chemical constituents as the apatite crystals of human enamel. It can adsorb effectively to the surfaces of teeth and hence is very useful in the re-mineralization process.4

Fluoride is an agent used for re-mineralization as it helps development of fluorapatite so brushing teeth regularly with fluoride dentifrice is beneficial, but there might be fluorosis and fluoride poisoning in children below the age of 6, an acid-resistant layer can form that prevents the diffusion of re-mineralizing ions into deeper layers.3

HAp and bones

Hydroxyapatite has similarities to bones. It's a ceramic used to reconstruct bone defects which result from bone diseases, congenital defects or trauma. It repairs bones. HAp is largely present in bones, and it regulates concentration of Ca2+ ions that promotes division of osteoblasts which leads to bone formation and division.

Cancer detection and cell imaging

HAp can also detect tumours as it is unique and has outstanding properties.5

Some research done inside as well as out of the cells have shown the eliminating properties of Hydroxyapatite nanoparticles towards the cancer or tumour cells which is one the most fatal diseases of recent times. The shape, size, and crystallinity of HAps are recognized as main factors responsible for their anticancer participations.6

Cons of Hap

In contrast to these benefits, HAp also has disadvantages, firstly it is brittle, and secondly its Nano forms (nHA) show aggregation due to weaker interface adhesion with polymers. These are huge challenges for its applications in the areas of bio related fields, therefore it still must cover a long way to prove and show its properties in bone tissue engineering.7

Conclusion

Hydroxyapatite is a very advantageous material in the medical sector due to its great properties and composition. It is used widely in orthopaedics as well as in dental fields for cure of caries, and in cancer diagnosis specially the Nano Hydroxyapatite. 90% of our teeth enamel and 60% of bone content is composed of Hydroxyapatite. But as every useful material has its own pros and cons, Hydroxyapatite also has a few disadvantages as well.

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