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Silver Nanoparticles and Its Application Pediatric Dentistry - A Review of Literature

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Abstract

The study of particles at the nanoscale size has been transformed by the word "nano technology" (1–100 nm). Nano particles (NPs) may be produced artificially, organically, or as by products. These materials have higher surface-to-volume ratios than non – nano scale particles, making them more reactive. These materials are preferred fillers and modifiers in a variety of goods and materials due to their special quality, which significantly enhances the qualities. Several instruments used in dentistry as well as medical procedures, treatments, and molecular diagnostics make use of silver nano particles (NPs).

However, recent research expressed worry about the risks to the environment and to human health linked with their use. Because to their high surface-to-volume ratio and small particle size, they have a great antibacterial impact without affecting the material's mechanical properties. Because of this unique trait, AgNPs are the ideal filler for a number of biomaterials where they greatly improve the properties. The effects of incorporating AgNPs into various biomaterials used in Pediatric dentistry will be covered in this review.

Keywords: Nano dentistry, Silver Nanoparticles, AgNPs

Introduction

Dentistry's main objective is to preserve the oral cavity because it serves as a doorway to the entire body. The majority of dental illnesses are primarily caused by plaque biofilm, and while many bio materials have been used to treat them, restrictions related to the material qualities preclude realisation of desired results.[1] By manipulating shape and size at a nanoscale scale, nano technology is the design, characterization, and

application of structures, devices, and systems (1 nm to 100 nm).[2] Silver nanoparticles are among the many nanoparticles that have attracted the greatest attention for research in recent years. Since many years ago, wound dressings, catheters, and prosthesis have all been made using silver (Ag) ions or salts, which are known to have a broad antibacterial impact. Ag is a powerful antibiotic, but it also has a number of benefits, including minimal toxicity, strong biocompatibility with human cells, long-lasting antibacterial activity due to continuous ion release, and little bacterial resistance.[3]

Applications of nano particles in dentistry have found utility in endodontics, Periodontics, resto rative dentistry, orthodontics, and the treatment of oral cancer. Due to its antibacterial qualities, silver nanoparticles (AgNPs) have been used in dentistry and medicine. AgNPs have been added to biomaterials to stop or lessen the growth of bio films.[1] The objective of present review of the literature is to discuss properties of silver nanoparticles and their applications in Pediatric dentistry.

Silver Nanoparticles in Dentistry

Like other products containing silver, the biological activity of AgNPs is mediated by the slow release of silver as a result of redox reactions in the presence of water. Moreover, the size and shape of nanoparticles affect their ability to inhibit the proliferation of bacteria, fungi, and viruses, with diameters less than 10 nm having the most anti-microbial effects. The variety of nanoparticles' nano-ionic origins can be used to explain the variety in sizes and forms.

Amorphous calcium AgNP-phosphate, Chitalac-Ag, AgNP-methyl polymethylmethacrylate, AgNP-methyl poly methyl methacrylate, and fluorides (Nano Silver Fluoride) are a few composite materials that contain silver nanoparticles in dentistry. In the form of silver nanoparticles or silver plasma, it can also be employed on its own.[4-6]

Production of Silver Nanoparticles

Since metallic nanoparticles have a high surface energy, silver nanoparticles are created using a precursor (often silver nitrate), a reducing agent that reduces silver ions from Ag+ to Ag0, and a stabilising agent that ensures the stability of suspended nanoparticles and prevents nucleation and aggregation. The creation of silver nanoparticles can therefore be chemical, physical, or biological.[6]

Chemicals that are poisonous and dangerous are used in the physical and chemical processes, raising questions about the health of the environment and living things. Hence, using less expensive, ecologically friendly biological approaches would be an alternative. The majority of biological techniques used fungi, bacteria, and plant extracts. For example, NADPH-dependent nitrate reductase is used in the formation of fungus like Fusarium oxysporum, Fusarium semi tectum, Aspergillus fumigatus, Aspergillus flavus, Aspergillus clavatus, etc. by trapping Ag + ions at the surface of the fungal cell.[7-11]

Application of Silver Nanoparticles in Pediatric Dentistry

Silver Nanoparticle Modified Glass Ionomer Cement

The glass ionomer cement (GIC), which is well-known for its fluoride release and storage capabilities, is used in numerous paediatric dental procedures. This release turns this cement into an anti-caries agent since fluoride prevents the bacterial enzyme enolase from working. In this situation, GIC would be more beneficial in preventing oral diseases if it were impregnated with antimicrobial chemicals that lasted longer. Gram-positive and Gram-negative bacteria are both susceptible to the antibacterial effects of the biomaterial produced

by the interaction of GIC and AgNP. According to the authors, the antibacterial effect is brought about by the release of silver ions, which leads to an oxidative breakdown in the cement matrix and inhibits dental caries as well as the growth of oral biofilms.[12,13]

Silver Nanoparticle in Caries Prevention

In numerous research, silver nanoparticles (Ag NPs) have been utilised to prevent dental cavities. These investigations made use of silver nanoparticles in sealants, glass ionomer cement with Ag NPs, dentifrices, coated orthodontic brackets, nano silver fluoride solutions, and silver nano composites. To treat and prevent secondary caries, in vitro study with silver nanoparticles and silver nanocomposites was conducted. In order to prevent caries, Ag NPs were also added to the resin of orthodontic products (adhesives, elastomeric ligatures, and detachable retainers). Early enamel caries might be remineralized, and dentinal caries could be stopped, using nano silver fluoride solution.[14-17]

Silver Nano fluoride (NSF)

Silver nanoparticles and fluoride have lately been mixed in inventive formulations. Both the cytotoxicity and anti-cariogenic efficacy of the silver nano fluoride suspension were studied in-vitro. The MBC was tested at 50.32 g/ml, while the MIC was measured at 33.54 g/ml. Comparing the findings to Silver diamine fluoride revealed no differences (SDF). Sadly, this investigation did not evaluate the enamel surface's deterioration.[18]

Also evaluated was a formulation that included fluoride, silver nanoparticles, and chitosan as a carrier. This customised varnish was used to treat dental cavities once, and observation intervals of seven days, five months, and twelve months were noted. In seven days, 81% of the samples had stopped developing cavities; at five months, 72.7% of the samples were still free of carious lesions; and at twelve months, 66.7% of the samples were still free of carious teeth. There were no deep, dark marks on the tooth enamel.[19]

Similar to this, a fluoride varnish with silver nanoparticles was tested for its ability to remineralize primary teeth with white spot lesions. After being examined with the DIAGNO dent laser wand, anterior primary teeth were added to the research. Fluoride varnish and silver nanoparticle powder were combined at a weight percentage of 0.1%. One tooth in each quadrant received the experimental fluoride varnish coating, while the opposing quadrant received the standard fluoride varnish coating. During three weeks, the therapy was administered once each week. At three months, follow-up examinations were conducted using the DIAGNO dent to assess changes in remineralization. After treatment with silver nanoparticles, it was discovered that the rate of remineralization was greater than that of plain water.[20]

Safety Concern of Silver Nanoparticle

Silver NPs' toxicity is one of its key characteristics for bio medical usage. The hazardous effects of nano materials are known as nano toxicity. The amount of active free Ag + ions released by AgNPs determines how hazardous they are. While the extraordinary promise these NPs hold for a wide range of applications, their unfavourable impacts on live cells have caused grave concern. Moreover, silver NPs can cause dental materials to discolour and produce corrosive chemicals when in touch with them. When these nanoparticles (NPs) with antibacterial characteristics are released into the environment, they endanger marine life. Debatable solutions must be found for each of these problems, which call for new approaches and methods.[21,22]

Conclusion

Dental materials' mechanical characteristics and antibacterial qualities may be improved by adding silver

nano particles. Many scientists think that silver nano particles can continuously discharge silver ions to kill germs, even if the exact mechanism underlying their antibacterial properties is still poorly known. Silver nanoparticle-containing dental materials are being created in greater quantity for prosthetic, restorative, endodontic, orthodontic, periodontal, and implant treatments. With silver NPs, paediatric dentistry actually has a promising future. Nonetheless, several issues need to be investigated and further investigated in order to be solved. We have high hopes for these small particles' future.

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