# Bacteriostatic Effect of Silver Nanoparticles over Acrylic Resin and Composite Dental Materials

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*Acrylic resin materials are used for making dentures, artificial teeth, veneers, crowns, and temporary crowns, etc. The surface structure of acrylic resins as well as composite resin and ceramic are a favourable environment to the bacterial plaque development. Researches from domain lead to more qualitative acrylic resin and polymers: diacrylic composite resins, epoxide resins, etc. Diacrylic composite resins have superior mechanical and aesthetic properties but are inferior to ceramics. The prosthetic restorations and the presence of different materials in the oral cavity represent a proper environment for the development of microbial flora. The oral cavity health depends on correct prosthetic treatments and a balanced microbial flora that can be controlled with bacteriostatic substances, oral hygiene and correct prosthetic restorations. Bacteriostatic effect of silver nano-particles over plastic dental materials may influence and contribute to the activity of bacterial micro-flora and may influence the evolution of periodontal disease and gingivitis by destroying the dental plaque.*

*Key words: acrylic resin, diacrylic composite resins, crowns, silver nano-particles*

Metal-acrylic and metal-polymer crowns became a restoration choice for reestablishing the esthetics and integrity of heavily destroyed teeth along with metal-ceramic or all ceramic crowns [1]. Metallic crowns with acrylic facings were introduced in the protocol treatment at the end of forties. One major disadvantage of this type of crowns was the bond stability of the acrylic veneer and the low properties of acrylic resins [2]. Studies, along time have reported that the margin of dental restorations stimulate bacterial recolonization. The acid produced by dental plaque affect the gingival neighbor tissue. Cervical area maintains a proper environment for bacterial development. Crowns made from different materials are maintaining the morphology and the function of the tooth. The materials and types of fix prosthesis can be all ceramic, full cast metal, metal-ceramic and metal-acrylic. These materials, through their properties and surface structure may create a support for development of dental plaque. The bacterial of dental plaque are subject to physiological and compositional shifts as a result of environmental stress generated by the placement of prosthetic restoration. This phenomenon may lead to complications, inflammatory process of gingival tissue and regression of alveolar bone [3]. Specific literature is mentioning that there is a various growth of certain bacteria in dental plaque according to used materials [4, 5]. The effect of fixed partial dentures and dental plaque over the host tissue is essential for the longevity and integrity of marginal adaptation of the prosthetic restoration, and integrity of gingival sulcus. The dental plaque may be controlled through precise and correctly designed fixed partial dentures, good hygiene in case of all material types that are in relation with gingival tissue (acrylic, polymeric, ceramic). The bio-film can easily become pathogenic if the balance between is disturbed. The pathogen character involves a high number of aggressive bacterial colonies, and fungus. The increased number of aggressive micro-organisms affects the status of gingival tissue that has contact with fixed partial dentures. Candida albicans adhesion to any oral substrate is the first stage in formation of a pathogenic bio-film. Yeast cells (candida albicans) have a great potential to adhere to host surface such as teeth, mucosa and artificial teeth. A disturbance of the immune and defense system of the organisms easily transform this micro-flora into a pathogenic one [6- 9].

This balance can be controlled through an active defense system, good hygiene and correct fixed partial dentures. Bacteriostatic substances present in oral tooth pastes and professional substances have a key role. Nano-materials domain is present in dentistry. Composites with nano-particles are already used in teeth direct restoration. Silver is known for its bacteriostatic effect. The new domain of nano-particles developed silver-nano-particles substance which is used with success in endodontic treatment.

Referring to silver nanometric scale, the particles size is less than 100 nm and has different catalytical properties and high toxicity to a wide range of microorganisms [10]. Studies mentioned by the specific literature have established the bactericidal effect of nanosilver in Gram negative and Gram positive bacteria. Other micro-organisms like Escherichia Coli, Pseudomonas aeruginosa, Salmonella, Bacillus, Streptococcus aureus or Enterococus faecalis are responding to nanosilver toxicity [11, 12]. The antiviral capability of silver nanoparticles against hepatitis B virus was also established [13]. Nanosilver was described as accelerating agent for wounds healing [14].

Silver nanoparticles size can be 100, 30–40, and 10 nm. Smaller nanosilver sizes are increasing the surface are and the antibacterial activity.

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The purpose of this study is to evaluate the bacteriostatic effect of nanosilver over different types of dental materials used for fix partial prosthesis. The oral micro-flora is micro-biologically evaluated according to different hygiene protocols and after the application of silver nano-particles. Nanocare+ is a pharmaceutical substance with a long-lasting bacteriostatic effect designed for final rinsing of the root canals during endodontic treatment based on silver nanoparticles and it is efficient over a large number of germs and bacteria.

Modern molecular biological techniques have identified about 1000 different bacterial species in the dental biofilm, twice as many as can be cultured. Their activity can be controlled with bacteriostatic substances such as nanosilver.

**Experimental part**

In the present clinical study were involved 24 subjects between 27 and 62 years old. These patients have partial edentulous dental arches of different materials. For this study were selected patients with metal-acrylic and metal-composite fix partial dentures. Acrylic and composite resins are belonging to the family of plastic materials.

Composite resins have superior properties toward acrylic resins. Mechanical properties, esthetics, stability of metal-composite interface are superior to acrylic resins. The acrylic resins suffer a modification in surface texture which is increasing its surface roughness in time. The gingival tissue responds positive or negative to the adaptation of the fix denture and to the micro bio-film.

A total of 18 metal-composite and 11 metal-acrylic fix partial dentures were evaluated in this study. Metal composite fix partial prosthesis maintain the marginal integrity along time. The colour is much more stable same as the surface structure. Water absorption is very low and occlusal stops are better maintained.

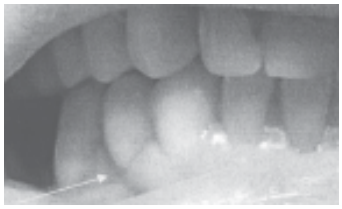

Fig. 1. Metal-composite fixed partial denture

Metal-acrylic fix partial dentures have inferior mechanical and esthetic characteristics. The bond between the acrylic resin and metallic core is often the cause of failure. It is difficult and almost impossible to obtain a smooth surface structure because of the poly (methyl methacrylate) (PMMA) powder which is not homogenously dissolved by the monomer. This micro-roughness is a proper substrate for bacteria development.

The oral micro-biology environment was identified before any hygiene maneuver. The micro-biological results were identifying species of *Streptococcus (mutans, oralis, salivarius anginosus), Staphylococcus (aureus, epidermidis),* Bacilli gram positive, *Actinomyces, (Odontolitycus, israelii, naeslundii),* Bacilli gram negative and *Candida albicans*. The sampling of microbiologic environment present in the oral cavity and into the micro-biologic film of the biological and artificial structures was made with dedicated probes with Stuart gel transporting medium. Before sampling the fixed partial prostheses were not washed with any tooth paste, antimicrobial or disinfected substance.

Fig. 2 Metal-acrylic fixed partial denture; over-shaped convexity of labial face and material defect of acrylic veneer in the cervical area

The first set of samples was preleased directly from the oral cavity. Micro-biologically flora was analyzed from the third cervical area of the metal-acrylic and metal-composite crown. Third cervical area of crowns is susceptible to dental plaque. The reasons are: an improper dental brush (soft), teeth sensitivity due to gingival retraction, incorrect convexity of the artificial crown or lack of marginal adaptation of the artificial crown. Dental calculus, gingivitis and periodontal diseases maintain the perfect environment for bacterial development. Tester samples were preleased with the same kit and sent to the microbiologic laboratory. The samples preleased from oral cavity were taken with sterile plugging and suspended in Stuart transport environment. Hygienic conditions were respected not to contaminate or over-contaminate the pledges. Each pledge was inoculated on blood agar 5%, *Sabouraud, Chapman* and *Mac Conkey* culture medium and incubated at 37°C for 24 h. After 24 h the isolated germs were identified after Gram coloration, morphology, and bio-chemical tests. The first set of analysis identified the micro-biological flora of each patient.

After 24 h each subject has washed the natural teeth and fix partial denture with its usual tooth paste and tooth brush. The subjects were performing their usual hygiene. Another set of samples were preleased just immediately after the oral hygiene. The microbiological test evidenced the same bacterial but in a decreased number of colonies.

The third set of analysis was made after another 24 h. Between the second preleased and the third one the subjects did not use any oral hygiene methods. For the third set of samples the subjects used tooth paste and an antiseptic mouthwash Listerin. The subjects rise the mouth with Listerin for 30 s as the manufacturer recommends. Micro-biological analysis evidenced a lower number of colonies and only few bacteria species.

The protocol for the fourth set of micro-biological investigation eliminates the classical methods of oral hygiene. After 24 h, time needed for the growing and development of dental plaque the nanosilver solution NanoCare+ was used and come to collision with the third cervical area of the labial face of the fixe partial dentures. In case of this lot were taken two assays. The first assay from metal-acrylic and metal composite fix partial dentures was taken at 2 min and the second one at 5 min. The samples from the oral cavity were taken with sterile plugging and suspended in Stuart transport environment. Each pledge was inoculated on blood agar 5%, *Sabouraud, Chapman* and *Mac Conkey* culture medium and incubated at 37°C for 24 h. After 24 h the isolated germs were identified after Gram coloration, morphology, and bio-chemical tests (table 1).

**Results and discussions**

Bacteriostatic effect was demonstrated by the present study and other studies from the specific literature. All the samples assayed in the fourth stage of this study were microbiological negative. Bacteria or fungus were not identified at the micro-biological tests after applying NanoCare Plus (silver nanoparticle solution). The microbiological results were negative for the samples assayed at 2 and at 5 min. Two minutes of nanosilver action over dental plaque are sufficient to obtain a germ free surface without any additional methods (mouthwash or brushing).

**Table 1**

MICROBIOLOGICAL RESULTS

| Assay | Time | Result |
|---|---|---|
| NanoCare Plus | 2 minutes | Germs and fungus free |
| NanoCare Plus | 5 minutes | Germs and fungus free |

The bacteriostatic effect in case of the fourth group is certain. The mentioned hygiene methods (mouthwash and brushing) are just reducing the quantity of micro-organisms and reduce the potential aggressive activity.

Silver nanoparticles' mode of action is different from the mode of action exerted by antibiotics (β-lactamics, quinolones, aminoglycosides, trimethoprim-sulfamethoxazole, and vancomycin).

Silver ions are binding to sulfhydryl groups, which lead to protein denaturation by the reduction of disulfide bonds (S–S → S–H + H–S) [23]. Silver ions can make complexes with electron donor groups containing sulfur, oxygen, or nitrogen that are normally present as thiols or phosphates on amino acids and nucleic acids [24].

Silver nanoparticles bacteriostatic effect over dentures infected with *Candida Albicans* was studied in [29].

## Conclusions

Nano-materials are present in many products. Tooth pastes already contain nano particles like hydroxyapatite but nanosilver is the most common material in the database, with 383 products listed [15-19].

Silver nanoparticles are proven to have antibacterial properties, reducing the risk of gum disease and bad breath caused by bacteria in the mouth. Its distribution in toothpaste remains limited to manufacturers due to risk of toxicity. It is already successfully used in endodontic treatment [20-22].

In periodontitis, knowledge of the source of pathogens and the route of infection is important for planning prevention strategies. The present protocols may be improved by associating efficient topic bacteriostatic substances for a better control of the evolution of gingivitis and periodontal disease [23 - 25].

Silver compounds (salts and colloids) are a potent bactericidal agent whose application is restricted to topical creams used to reduce the risk of wound infection and to treat infected wounds. Silver nanoparticles as new antimicrobial agents can be the principal aim of new researchs [26 - 28].

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