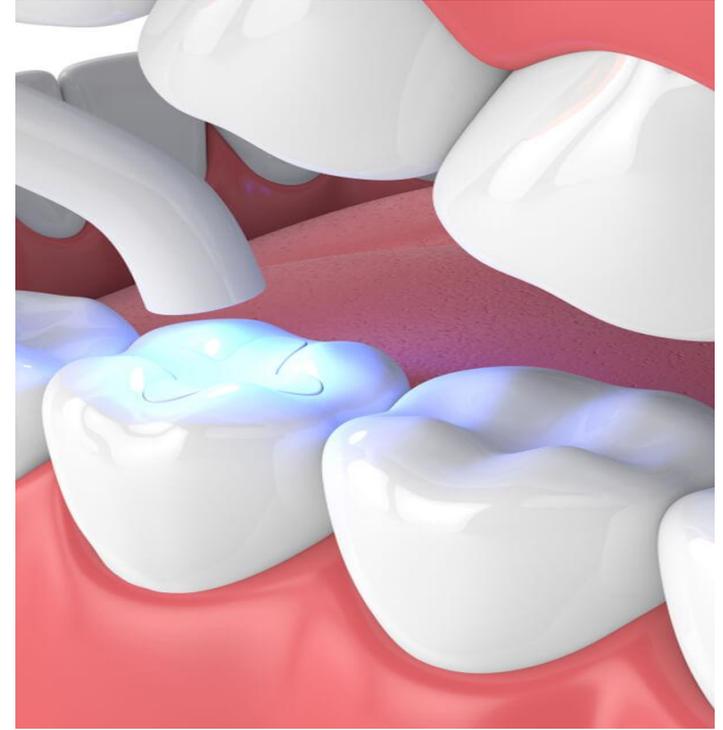


# Antibacterial Nanoparticles in Dental Composites

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D206



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# Introduction

Tooth decay is still one of the most widespread diseases in humans worldwide.

- 2.4 billion people ( 33% of population) worldwide suffer from dental caries in permanent teeth
- 60-90% of school children affected by dental decay globally

Significant number of caries occurrence are **secondary** or **recurrent caries**.

- Major causative factor for dental restorative material failure
- Prevalent amongst adults and elderly
- Occur at the margin or surface of existing restorations
- Estimated to affect over 100 million patients a year, at an estimated cost of over \$30 billion worldwide

# Current Composite Technology

Resin-based composites most commonly used in modern dentistry

- Optimal esthetic properties
- Color stability
- Polishability
- Less invasive preparation technique than amalgam
- Good mechanical and physical properties
- Suitable biocompatibility

Disadvantages of resin-based composites

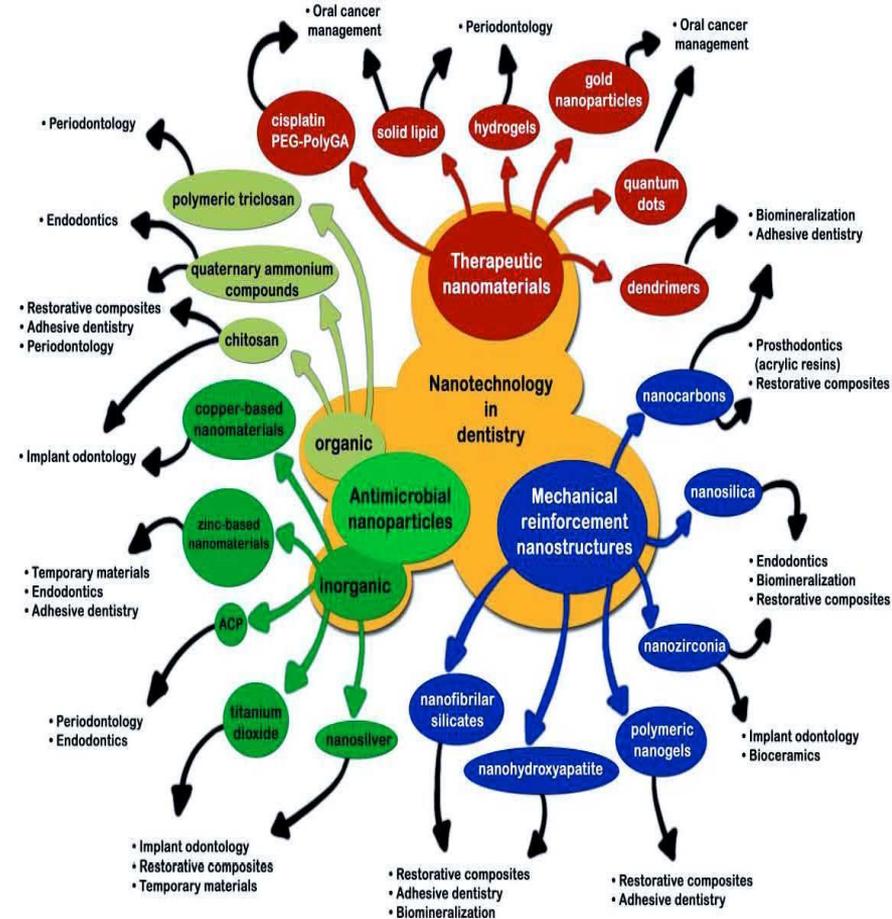
- Collect **more biofilm and plaque** than any other direct restorative materials
- Susceptible to **microleakage**- main cause of secondary caries

# New Technology & Research

Introduction of antibacterial components incorporated with resin-based restorative materials

Prominent agents include

- Classic antibiotics
- Fluoride
- Chlorhexidine
- Antibacterial nanomaterials and carriers
- Silver-based composites
- Iodine
- Zinc
- Quaternary ammonium compounds



# Novel Antibacterial Resin-Based Filling Material Containing Nanoparticles for the Potential One-Step Treatment of Caries

## Introduction

- A resin base filled with Zinc nanoparticles was developed at The National University of Cordoba.
- The purpose of this study was to create a resin based composite enhanced with nanoparticles to inhibit the growth of bacteria on tooth surface.
- If effective, this resin based filling could offer a minimally invasive treatment opportunity for patients, significantly decreasing the possibility of recurrent decay.

## Methods

- Third molars (in vitro) were treated with bacterial strains *Streptococcus mutans*, *Streptococcus mitis*, and *Lactobacillus*.
- The third molar pieces were then covered with a demineralizing solution that has a pH of 4.5 to mimic a potentially carious area for 72 hours.



# Novel Antibacterial Resin-Based Filling Material Containing Nanoparticles for the Potential One-Step Treatment of Caries

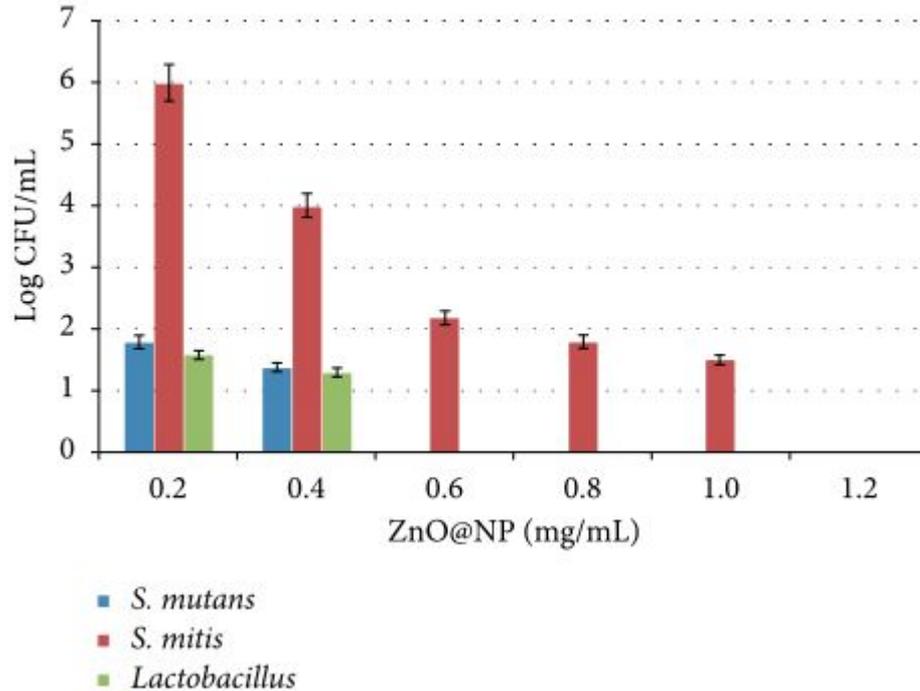
## Methods (continued)

- The resin and zinc nanoparticle base from a saline solution were then added to the demineralized area and after five minutes, measurements were taken.
- The measurement of bacterial growth, after being treated with the solution, was determined by the colony forming units and its turbidity .

## Results and Conclusions

- The results show a significant inhibition of these common bacterial strains found in the oral cavity.
- The resin composite's effectiveness as a restorative material was not hindered by the addition of zinc nanoparticles.
- If this material works just as effectively in vivo, this material would reduce accumulation of oral bacteria that destroys tooth surface.

# Results and Conclusions



- *S. mutans* growth is inhibited at ZnO nanoparticle concentration of 0.6 mg/mL
- *S. mitis* is inhibited at 1.2 mg/mL
- *Lactobacillus* growth is inhibited at 0.6 mg/mL

# Study: Development of Novel Dental Restorative Composites with Dibasic Calcium Phosphate Loaded Chitosan Fillers

## Introduction & Purpose

- A pre-clinical ( in vitro) study of new experimental resin composite to assess antimicrobial properties as well as chemical, mechanical and biological characteristics.
- Researchers combined standard use resin materials with particles of **chitosan** or **chitosan loaded with dibasic calcium phosphate anhydrous (DCPA)**.
- Chitosan- natural antimicrobial agent used in dentistry and medicine, derived from **chitin** ( can be extracted from seafood shells).
- **Calcium phosphate** has been known to remineralize tooth structure but weaken resin-based dental composite in previous attempts to incorporate it into dental composites structure.

## Methods

- Experimental composites contained either 10mg/ml of chitosan powder or 10mg/ml chitosan plus 2.5 mg/ml DCPA.
- Measure toxicity to cells and ability to cause genetic mutations of human fibroblasts from dental pulp of teeth.
- A test for primary amines was used to determine if chitosan was released from experimental composite.
- A single bacterial strain *Streptococcus mutans* was used to determine antibacterial properties
- Mechanical properties were measured after 24 hour and 90 day storage in distilled water.

# Study: Development of Novel Dental Restorative Composites with Dibasic Calcium Phosphate Loaded Chitosan Fillers

## Results

- All of the experimental composites showed no cell toxicity or ability to cause genetic mutations of human fibroblasts from dental pulp.
- Chitosan particles did not diffuse or was released into aqueous solution.
- 20% reduction of biofilm formation of *Streptococcus mutans*.
- Mechanical properties did not change after 24 hours or 90 days of storage in distilled water.

## Conclusions

- Experimental composite showed very promising antimicrobial properties without showing any signs of mechanical deficiencies or defects.
- Antimicrobial effect due to interaction between chitosan's positively charged amine groups and negatively charged bacterial cellular membrane- change in cell membrane permeability impairing vital bacterial life activities.



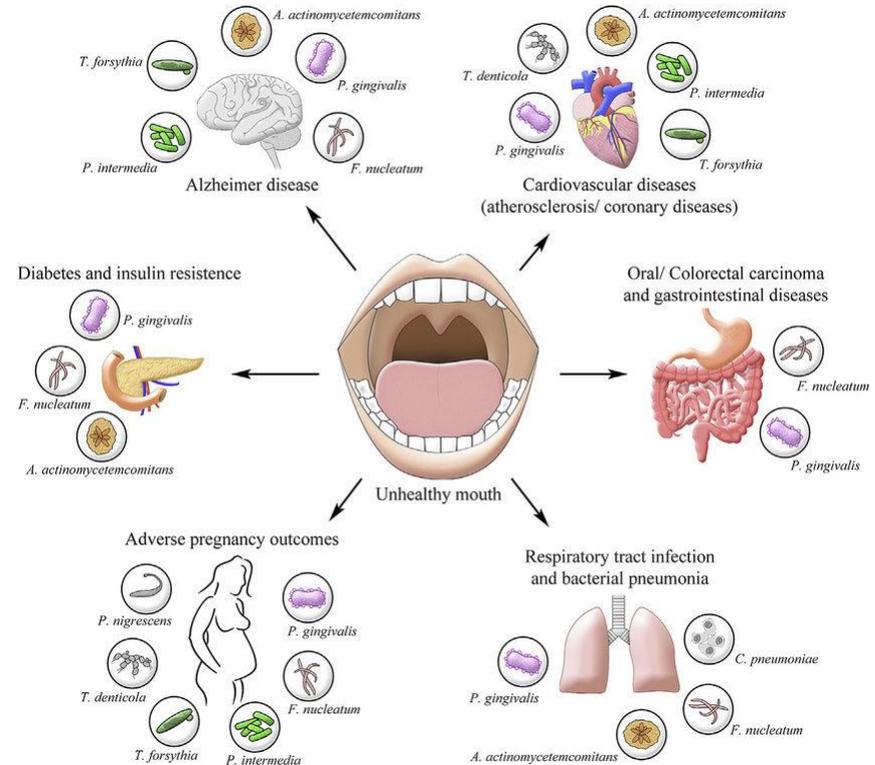
# Importance to Dental Hygiene and Patient Care



- Constant evolution in Dentistry - new products, technique and advancement
- Knowledge of current dental materials and treatment options most important in helping patient's understanding and choice of beneficial treatment
- Unique opportunity for Dental Hygienist to introduce, discuss and answer questions about restorative treatment options with a patient
  - “The patient's confidence will be increased when the knowledge level of the dental office team is perceived as high, and if questions can be answered by not only the dentist, but by office and clinical team members as well” - Dentistry Today

# Importance to Dental Hygiene and Patient Care

- Oral bacteria has negative impact on overall health and well being.
- Link between oral bacterial accumulation and systemic disease
- Dental Hygienist must emphasize the importance of proper homecare and disease prevention



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