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Review Article

Dental Caries Vaccine – A Change

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Abstract

Vaccines are immuno-biological substance that are used for many diseases as cure and treatment. Dental caries is a most common dental pathology. Many attempts had been made to cure this infectious disease by vaccine in the form of protein, recombinant or synthetic peptide, or DNA-based active vaccines and mucosal adjuvants on animals and it got positive response but still has many biocompatibility issues in normal human oral cavity because of dental caries vaccine.

Keywords: Dental Caries; Caries Vaccine; Streptococcus mutans

Introduction

Dental caries is an infectious microbiologic disease of the teeth that results in localized dissolution and destruction of the calcified tissue [1]. Dental caries depends on four triads- Microorganism (*Streptococcus mutans, Lactobacillus acidophilus, Actinomyces viscosus*), Substrate (extrinsic carbohydrates, intracellular polysaccharides), Host (smooth surfaces, pits and fissures) and fourth triad is added by newbrun that is time.

Latest advancements in dentistry for oral health education, chemical and mechanical control of plaque such as application of pit and fissure sealants, use of fluorides, etc. Now in dentistry researchers are trying to find the use of dental vaccine in future which will be biggest boon for public health [1,2].

What are Vaccines?

Vaccines are an immuno-biological substance that help in the production of a protective antibody and other immune mechanisms. Vaccines are combination of live, inactivated or killed organisms, modified organisms extracted cellular fractions, toxoids, or a combination.

Dental Caries Vaccine: It can be developed by identifying specific bacterial cause of dental caries and the function of salivary glands as an effector site of the mucosal immune system.

Microbiology

Various variety of microorganisms are found in carious lesions which are as follow: Mutans group of streptococci -*S. mutans, S. sobrinus, S. rattus, S. ferus, Streptococcus mutans, Lactobacillus* and *Actinomyces species.*

***Streptococcus mutans*:** It is Gram positive and facultative anaerobe and colonize the host only after the first teeth erupt. They are mostly found on the surfaces of the teeth and their percentage in the plaque is more at starting of dental caries over initiated by consumptions of sugar content. They synthesize macro-molecules from sucrose that binds to the tooth structure and generate carbohydrates, including sucrose, and are tolerant to low pH. They are generally found in initial sites on carious lession [3].

Antigenic determinants of *S. mutans*

Adhesins: Adhesins have been purified from the two principal micro-organisms- Streptococcus mutans and Streptococcus sobrinus.

Glucosyltransferases (gtfs): Three forms of GTF's:

- Water-soluble glucan synthesizing enzymes: GTF-S
- Water insoluble and water-soluble glucan synthesizing enzymes: GTF-S-I.
- Glucan synthesizing enzyme: GTF-I.

Genes encoding the 3 forms are:

- GTF-C - GTF-S: GTF-I: GTF-B - GTF-SI: GTF-D [4,5].

Glucan Binding Protein (GBP): They release 3 distinct proteins with glucan binding activity: GBP-A, GBP-B and GBP-C. It helps in adhering of glucan to *S. mutans*. It helps in increasing the porosity of the dental biofilm, thus increasing the availability of nutrients for continued bacterial metabolism.

Dextranases: Dextran is basic content of early dental plaque and its enzyme (Dextranase) removing the dextran and thus the bacteria can invade dextran-rich early plaque. Dextran, it helps in the prevention of the colonization of the organism at early stage.

Mechanism of Action: Salivary immunoglobulin may interact with bacterial surface receptors and inhibit colonization. May inactivate surface glucosyltransferases, which would reduce synthesis of extra cellular glucans resulting in reducing plaque formation. Secretory IgA from salivary glands due to direct immunization of gut associated lymphoid tissue (GALT):

- May prevent MS from adhering to the enamel surface.
- May also prevent formation of dextran by inhibiting the activity of glucosyltransferase (GTF).

Gingival crevicular mechanism: All humoral and cellular components of systemic immune system, that exert its function at tooth surface [6-11].

Various Methods of Administration: Common Mucosal Immune Pathway

- Systemic Route
- Active Gingivo-salivary Route

Common Mucosal Immune System: Mucosal applications of dental caries vaccines are generally preferred for the induction of Secretory-IgA antibodies. Following methods are using:

Oral Route: Relied on oral induction of immunity in the GALT. Oral feeding, gastric intubation, or in vaccine containing capsules or liposomes are best way of application for antigen.

Intranasal Route: The NALT, procedure for nasal route administration has been used to induce immunity to bacterial antigens to avoid colonization and accumulation of microorganisms.

Figure 1

Minor Salivary Gland

They are best route for mucosal induction, with less time, broad secretory ducts that give retrograde access of bacteria and their products.

Rectal

Because of the highest concentration of lymphoid follicles in the lower intestinal tract it is known as inductive location for immune responses.

Systemic Route: This route was use IgG, IgM and IgA antibodies. The antibodies find their way into the oral cavity via GCF and are protective against dental caries. The development of serum IgG antibodies takes place within months of immunization.

Figure 2

Active Gingivo-Salivary Route

In order to reduce side effects, gingival crevicular fluid is found to be best route of administration. Both IgA and IgG antibodies are induced.

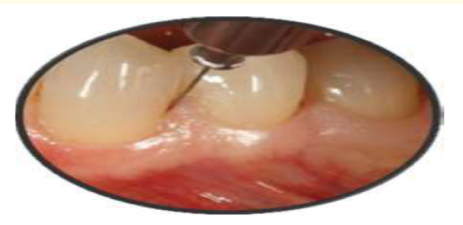

Figure 3

Passive Immunization

It involves passive of the antibodies. Several researches are as follow:

1. **Monoclonal antibodies**: These antibodies to *S. mutans* cell surface Ag I/II have been examined. Topical application where *S. mutans* are more in number found to be more effected and showed massive reduction.
2. **Bovine milk:** This milk reduces caries because of containing polyclonal IgG Abs. While using for mouth wash it helped to reduces the percentage of *S. mutans* in plaque.
3. **Egg-yolk antibodies:** Caries reduction were noticed due to presence of formalin killed whole cells and cell associated GTFs.
4. **Transgenic plants:** Vaccine is tasteless, colourless and can be applied onto the teeth. It is the first plant derived vaccine from plants which are genetically modified.

Adjuvants and Delivery Systems for Dental Caries Vaccine

Coupling with Cholera Toxin subunits:

- It is a powerful mucosal immune adjuvant.
- Addition of CT or E. coli heat labile LT: enhances immune response.

Microcapsules and micro particles: Microcapsules and micro particles of polylactide-coglycolide (PLGA) used as local delivery systems.

Fusing with salmonella: It act as effective vaccine vector when fusion done with various recombinant techniques.

Liposomes: Because of mucosal immune responses by facilitating M cell uptake and delivery of antigen to lymphoid elements of inductive tissue, it improves drug delivery [12-15].

Advantages

- Prevents the disease in children
- Can be incorporated to universal immunization programme
- Cost effective in the long run
- Provides lifelong immunity etic peptides-Antigen derived from animals/ humans has potential for hypersensitivity and give antibodies in GCF and saliva.

Disadvantages

- Risk of hypersensitivity
- Cross reactivity of certain antigenic components of *S. mutans* with heart tissue (structurally similar to myosin)
- Microbial resistance

Conclusion

Dental caries vaccine has big scope in future. Still many researches are going on to make dental caries vaccine biocompatible human race. However, there is no vaccines in present health sector that will give long term protective barrier against dental caries. Second big challenge is elimination of specific microorganism from oral cavity with the use of dental caries vaccine [16].

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