

Caries Vaccine: An Insightful Overview

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ABSTRACT

Regardless of massive accomplishments in scientific technology and technical knowledge, dental caries remains to be an immensely common pathology. The bacteria accountable for instigating caries comprises chiefly of Streptococcus Mutans followed by Lactobacilli and Actinomyces group. The dental management of a carious tooth structure necessitates colossal aggregation of patient's money and dentist's time. Therefore, it is highly vital to cultivate methods of control and deterrence. Contemporary advances in the dental caries vaccine have revealed promising results and the core purpose of the editorial is to provide a profound comprehension of the caries vaccine.

KEYWORDS: Caries; Vaccine; Immunity

INTRODUCTION

Amongst all the oral pathologies, dental caries has been recognized as relatively common in human beings.¹ It has known to distress all race groups and is relentlessly prominent in both the developed and under-developed countries. The recent rise in caries rate has affected age groups of all kind, thereby involving both primary and permanent dentition. In a country like India, the prevalence of dental caries in children going to school has been reported over 60%. In a developed country like the United States of America, dental caries prevalence in school children is about 45% and has been recorded up to 95% in adults. Such a high prevalence rate has intrigued the human race to devise alternatives to control and prevent dental caries.

A carious tooth structure is a result of decalcification caused by certain groups of microorganisms, categorized by the obliteration of both the organic as well as the inorganic portion of the tooth.² The most frequently acknowledged etiological group of bacteria are the streptococcus mutans. Amongst the streptococcus family, S.mutans and S.sobrinus are the maximum dominants segregated from the humanoid oral caries. Studies have demonstrated that the use of appropriate patient education, plaque control measures, fluoride application and use of sealants as a comprehensive means of declining the caries rate. However, due to negligence, it is imperative that a tactic to battle caries is established through the deployment of an effective vaccine.

VACCINATION

A vaccine has been designated as an immune-bio element with a fundamental tenacity to perceive protection against a particular pathology. The common mechanism of action indulges use of several immune contrivances to protect the living being. Vaccines are generally industrialized from either living or dead organisms with the help of hauled out segments of cellular structure.

Proposed Mechanism of Action: Along with the manifestation of immunoglobulins namely IgG and IgM and cells like neutrophils and lymphocytes from the fluid of gingival sulcus in the oral cavity, there is an abundance of secretory IgA in the saliva. One of the primary proposed mechanisms of action of dental caries vaccine is through the interaction of the agglutinin which is usually in the form of an immunoglobulin in the saliva with the receptors present on the surface of the streptococci. Such a collaboration results in a drop in the cluster establishment of the bacterial groups, thus generating a comprehensive cessation in caries formation.³ The second proposed mechanism involves the enhancement of direct access of the salivary IgA to the surface of the tooth. The secretory IgA has been anticipated to inhibit the activity of glucosyltransferase, thereby creating a significant halt in the formation of dental caries.⁴

Caries Vaccine Study: A study was conducted by a group of researchers in London to demonstrate the efficacy of the caries vaccine.⁵ The study started by the generation of antibody in tobacco plant from its parent immunoglobulin. With the utilization of such steps, a liquid state vaccine for S. mutans was developed. A group of subjects was selected for the testing of the vaccine and this was followed by the application of liquid vaccine at least two times a week for a couple of weeks. On routine intervals as per schedules, the samples of plaque, as well as saliva were collected from the patients' mouth to observe the presence of the S.mutans. All the subjects who have received the liquid vaccine showed bacteria beneath an evident limit in saliva samples as well as the plaque samples.

Caries Vaccine Trial: A caries vaccine research trial was conducted by an assembly of investigators.⁶ Based on the theoretical understanding that an increase in the antibodies in the saliva would create a significant decline in the acid production by the bacteria and hence also reduce its adhesion to the surface of the tooth, a mucosal

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vaccination was developed. The trial was conducted on a collection of rats that were infected with a set of streptococci bacteria. There were three groups in which the first group was not vaccinated at all, the second group was vaccinated intranasally with streptococcus mutans along with free cholera toxin and the third group was vaccinated intranasally with free cholera toxin. The cholera toxin is added to increase the capacity of the human body to absorb the vaccine. The second group showed high concentrations of antibody response level as compared to the other two groups. This led to the sublime conclusion that the vaccine is indeed successful in reducing the dental decay.

Types of Immunization:

1. Active immunization: Active immunization with the help of antigens has proven to be effective against dental caries. Studies performed have demonstrated that when the human subjects are exposed to GTF from the streptococci group of bacteria, it causes the development of IgA antibody. A study was conducted in subjects including a child group and an adult group which was provided oral immunization with GTF antigen derived from *S. mutans*.⁷ Strong response of immunoglobulin IgA2 was seen in a large number of individuals. Moreover, the group was given nasal immunization which led to a positive antibody response of immunoglobulin IgA1. On comparison, oral immunization was on a lower scale as compared to the nasal immunization. Such studies have undoubtedly validated that such active immunization against dental caries could be extremely effective.
2. Passive immunization: A short-term decline in the amount of *S. mutans* has been observed in the oral cavity with the aid of passive immunization with mouthwashes containing bovine milk. A long-term decline in the amount of *S. mutans* had been perceived with the usage of IgG excerpt from mice.⁸ Results have shown decline levels of bacteria for a longer phase of time if treated with chlorhexidine mouthwash too along with the passive immunization. Also, it has been proved that the secretory IgA antibody has far better efficacy as compared to the IgG.

Susceptible Targets for Vaccine: In the entire process of caries formation, there are several phases which can prove to be susceptible targets for the dental caries vaccine. Antibodies in the vaccines can either decline the bacteria in the oral cavity before they could multiply or could lump the colonization receptors like adhesins and glucan binding proteins. Moreover, dextran is a significant component of the initial plaque and dextranase is the enzyme that is formed by *S. mutans*. The enzyme is known to terminate dextran, thereby which the *S. mutans* can overrun the initial plaque. With the aid of dextranase as an antigen, the colonization of the bacteria in the initial plaque can be controlled.

Routes of Vaccine Delivery: Various routes have been proposed for the effective delivery of the caries vaccine. They are as follows:

1. Oral Route: In a study, it was established that the oral administration of the vaccine was not exceedingly prosperous as paralleled to the subcutaneous route of immunization.⁹ The antibodies producing immunity were significantly of a smaller size and were active only for a small duration of time.
2. Nasal Route: Using the intranasal application of the antigens of the *S. mutans* in the rats, promising results have surfaced as paralleled to the oral route. Whether the use of adjuvants makes a positive difference or not is yet to be established.
3. Tonsillar Route: Tonsils have a dominant immunoglobulin IgG; however IgA is also present in sufficient amount. Experiments conducted in rabbits have deduced that submission of suppressed streptococci bacteria prompts an immune response that induces an increase in IgA on repeated applications.
4. Systemic Route: An experiment conducted on the monkeys concluded that the subcutaneous administration of the contents of the bacteria resulted in increased amounts of antibodies and immunoglobulins like IgG, IgA, and IgM. The antibodies were found to enter the oral cavity with the help of the GCF fluid.

Caries Vaccine Risk: In spite of all the necessary precautions taken in the process of manufacturing and delivering the vaccine, there are some unavoidable risks associated with the vaccine. One of the major risks observed are the patients suffering from rheumatic fever. There have been series of episodes of cross-reactivity amongst the vaccine made from the *S. mutans* with the heart tissue antigens.

CONCLUSION

Evidence over a period of decades has clearly demonstrated the role of *S. mutans* in the etiology of dental caries. A vaccine that has been derived from those bacteria will prove to be a vital asset. The research for the development of such vaccine is at a very primitive stage and it is imperative that important steps are taken to provide either active or passive immunization against the pathology.

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