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The effect of using topical fluoride with aloe vera extract on frequency occurrence of plaque and caries in early childhood

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Abstract

Background: Risk level of caries in Indonesia is relatively high. Thus, preventive measures are needed to overcome ongoing plaque and caries problems. One of the steps that can be taken in preventing plaque and caries in early childhood is through topical fluoride with aloe vera extract.

Purpose: The purpose of this study was to find out more regarding the effect of topical fluoride with aloe vera extract on frequency of plaque and caries occurrence in early childhood. Methods: The method used in this study is systematic literature review. The sources used in the systematic literature review are published sources and are recognized both nationally and internationally and can be accessed through PubMed, ResearchGate, Google Scholar, and ScienceDirect.

Results: Topical fluoride with aloe vera extract can prevent caries because fluoride works by inhibiting demineralization, increasing remineralization, increasing enamel resistance to acid attack, and reacting with hydroxyapatite to form fluorapatite. Aloe vera also contains anthraquinones, saponins, and flavonoids which have antibacterial properties and can dissolve lipoproteins in bacterial cell membranes. The topical fluoride preparation used is in the form of a gel with a concentration of 12.300 to 12.500 ppm and is used 4 minutes every 3 months and is not overused because it can cause fluorosis.

Conclusion: The use of topical fluoride in combination with aloe vera extract has a considerable success rate as a preventive measure in preventing caries in early childhood.

Keywords: Topical fluoride; Dental plaques; Caries; child; Aloe vera

1. Introduction

Healthy teeth and mouth conditions are the first steps to maintaining general body health. The reason that supports this statement is that in a person's oral cavity, there are microorganisms that have the second highest complexity after the large intestine with a total of about 700 species. Microorganisms present in the oral cavity certainly have an important role in the development of periodontal disease and multiorgan systemic complications which are far more complex [1].

Caries is one of the most common chronic diseases in the world, especially in developing countries like Indonesia. Based on the results of Riset Kesehatan Dasar (Riskesdas) conducted by the Ministry of Health of the Republic of Indonesia in 2018, it is said that the largest proportion of dental and oral diseases experienced by Indonesian people is 45.3% with complaints of damaged, cavities or diseased teeth, and 14% with complaints of swollen gums and abscesses. From these data, it was found that only 7% of all children in Indonesia are free from cavities. In this situation can be shown by the

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highest prevalence of cavities, namely in early childhood with a percentage of 93%. The risk of caries in children is divided into three levels, namely low, medium, and high levels. Based on these data, it can be said that the level of dental and oral health of children in Indonesia is classified as high caries risk, which means very bad. Thus, preventive action is needed to overcome ongoing dental problems [2].

Several preventive steps can be taken in order to prevent plaque and caries in children and contribute one of the points SDGs is "Good Health and Well Being" by applying the correct tooth brushing technique, Elementary Dental Education, regular check-ups to the dentist every 6 months, fissure sealants, and administration of fluoride [2].

Administration of fluoride is believed to reduce the percentage of caries. This can happen because fluorapatite can be converted from hydroxyapatite in enamel by fluor, which condition can cause the condition of the enamel to have resistance to acid dissolution which results in an increase in the remineralization process, an inhibition of the demineralization process, and inhibition of glycolysis in caries bacteria. Fluor also has two effects, namely systemic effects and topical effects. Systemic effects of fluorine can be in the form of supplements, fluoridated formula milk, salt, and mineral water. Meanwhile, the topical effect of fluorine is in the form of a gel, mouthwash, gel, toothpaste, and Silver Diamine Fluoride (SDF). Topical fluoride is said to be more effective if there is a combination of preparations in its use. In this study, topical fluoride with aloe vera extract was used as a preventive measure for caries and plaque in early childhood. The aim of this study was to find out more regarding the effect of topical use of fluoride with aloe vera extract on the frequency of plaque and caries occurrence at an early age [3]

2. Material and methods

In doing literature reviews the method used systematic literature rereview and data analysis. Systematic literature review is the preparation of a literature review that is carried out in a systematic way. This method requires that the source is studied in detail and differs from the study literature reviews others whose sources can be obtained from anywhere. The systematic literature review highlights various aspects of research that have been published. The main aspect of systematic literature review authors must pay attention to it so that it can be recognized and accepted in national and international reputable journals. The search sources that researchers use can be obtained and accessed through PubMed, ResearchGate, Google Scholar, and ScienceDirect.

3. Results and discussion

3.1. Function and Role of Teeth in Children

Teeth are a part of the body that has a role to maintain facial shape, speech, mastication, and aesthetics. Deciduous teeth or what is often referred to as baby teeth means temporary teeth in children that grow for the first time and will later be replaced by permanent teeth. Primary teeth in children generally number 20 which consist of central incisors, lateral incisors, canines, first molars, and second molars. The condition of the primary teeth in children is very important. This is because the condition of the primary teeth in children can determine the condition of the child's teeth in the future and can affect overall health. Therefore, to achieve optimal dental health, regular dental care is needed in early childhood [4].

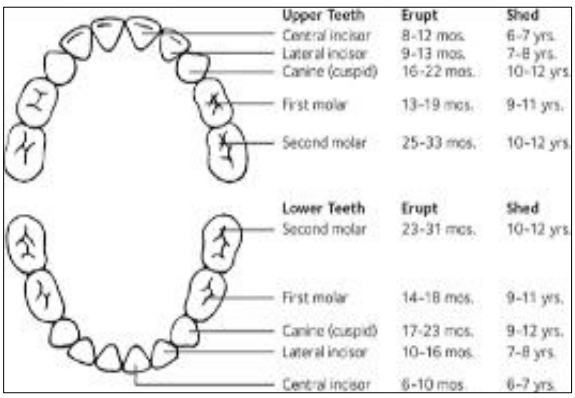

Figure 1 Deciduous Teeth in Children

As previously explained, teeth in children have several functions, namely as follows. (1) Phonetics or speech functions, in speaking teeth have a role to pronounce certain letters such as F, S, V, Z, and Th. If there is damage to the teeth or there are missing teeth, it will result in disruption of the pronunciation of some of these letters. (2) Aesthetics or the function of beauty, in which self-confidence in children will increase if the condition and structure of the teeth in the child are neat and intact. Primary teeth have a role in maintaining the shape of the dental arch as a guide for the replacement of permanent teeth which will later grow to replace the primary teeth. Premature loss or premature loss of primary teeth occurs and this will result in replacement permanent teeth that will grow later in which there is a wrong direction of growth and a lack of space in the permanent teeth. (3) Mastication or what can be referred to as a function of mastication, children who experience toothache can cause children to have difficulties when consuming food, thus causing a reduction in nutritional intake obtained by children. The golden age is a period of active development and growth of the body. Apart from the lack of nutritional intake, the growth of the child's jaw is also affected by toothache. If the masticatory function is not carried out optimally, it will result in the growth of the jaw not being maximized. Jaws that do not develop replacement permanent teeth experience a lack of space to grow. This causes teeth to be crowded or it can be said that they will grow crowded with the position of the front teeth protrusion or it can be said to be more advanced [5].

3.2. Early Childhood Caries

Dental and oral health are two main things that complement each other and cannot be separated from body health. In the growth and development of children, it is also necessary to pay attention to dental and oral health problems. Children who suffer from dental and oral diseases at an early age are prone to malnutrition [6]. Caries is an infectious process that causes tooth structure to be damaged resulting in the development of various new diseases in the oral cavity. Dental caries also have an unfavorable impact on the survival of children at an early age [7]. *Streptococcus mutans* are the main bacterial species in dental plaque and have an important role in the etiology of caries. The function of converting sucrose into fructans and glucans is owned by the fructosyltransferase and glucosyltransferase enzymes found in *S. mutans*. This aids in the attachment of other types of bacteria to the teeth. The accumulation of caries-causing bacteria results in high acid production which results in a decreased plaque pH and triggers caries to develop [8]. Caries in early childhood tend to occur more quickly because it is easier for caries to attack tooth enamel, which is the outermost layer of newly erupted teeth. This is caused by immature tooth maturation. Early Childhood Caries or often abbreviated as ECC is a type of caries that is common in children.

Figure 2 Clinical Features of Early Childhood Caries

The cause of ECC is consuming too many drinks such as milk or drinks with high sugar content by using a bottle when the child sleeps during the day or night. This habit is not balanced with efforts to pay attention to oral hygiene. ECC in children causes pain, difficulty speaking, and chewing which can cause swelling. There are several ways to prevent ECC and one of them is the use of fluorine. ECC has certain characteristics with a distinctive pattern and the process of occurrence is very fast compared to normal caries. The color of the carious cavity is white to yellowish. The clinical picture of developing ECC follows a specific pattern. Its pathogenesis is related to the pattern of the eruption of primary teeth and generally begins on the labial surface of the upper anterior incisor [9,10].

3.3. Fluoride

Fluoride is a material that has bacteriostatic properties and is widely used in dentistry. The prevalence of caries can be reduced by fluoride which is the main agent in the caries reduction process. This can happen because fluoride has a mechanism of action by inhibiting demineralization, the metabolism of caries-causing bacteria which can ferment

carbohydrates through changes in fluorapatite in the enamel from hydroxyapatite becomes inhibited, inhibits the formation of plaque on teeth, and triggers remineralization [5].

Fluoride itself has a mechanism of action by inhibiting the absorption of salivary proteins on the enamel surface, which results in the inhibition of plaque and pellicle formation. Not only that, the resistance of enamel remineralization to acid will increase and there will be inhibition of acid formation and decrease in enamel. In addition, fluoride also has an antimicrobial effect which this antimicrobial effect can prevent caries growth. Acid-resistant enamel is produced by a chemical reaction: Ca10 (PO4)6.(OH)2+ F → Ca10(PO4)6.(OHF) thereby causing an increase in the process of remineralization and inhibition of demineralization which can stimulate the repair and termination of carious lesions [2].

There are several ways of working with fluoride, the first is by increasing the density of tooth crystals. Crystal size can be increased by fluoride so that a lower voltage is produced on the crystal side. This occurs through the conversion of hydroxyphosphate from calcium phosphate. The second way of working is the void theory, in which the stability will decrease and the reactivity of the crystal will increase if there is a vacancy in the crystal. The third way is through acid solubility, fluoridated fluorapatite with a solubility of 10.60 has a solubility that is not easily soluble compared to hydroxyapatite which has a solubility of 10.55 so it can be said that fluorapatite is more stable. The fourth way is by inhibiting enzymes, enolases and glucose transport will be inhibited by fluoride. Enolase itself is a metalloenzyme that requires a divalent cation for its activity. Fluoride is also very reactive towards forming bonds with divalent cations which can result in inhibition of bacterial metabolism. The fifth way is to suppress the flora in the oral cavity, Stannous fluoride (SnF) has a very potent growth suppressor in the oral cavity. This can happen because SnF can oxidize thiol groups so that it can inhibit bacterial metabolism. In addition, the way fluoride works can also be through antibacterial, protein, and bacterial desorption, reduced energy on the free surface, and changes in tooth morphology [5].

3.4. Aloe Vera

Utilization of plants and their derivatives which are known to have preventive and therapeutic effects can contribute to dental and oral health [11]. Aloe Vera is a plant from the Liliaceae family. Aloe vera plants grow ideally in areas with tropical climates with low rainfall [12]. Aloe Vera has been used in the field of dentistry since 1982 when it was used to treat periodontitis [13]. Extract from Aloe Vera leaves contains a bioactive which acts as an antibacterial [14]. Aloe Vera is used as an oral antiseptic for the prevention of dental caries and periodontal disease [15]. Because it has antimicrobial and anti-inflammatory effects [16, 17].

3.5. Definition and ingredients of Topical Fluoride with Aloe Vera Extract

Topical fluoride is a technique used in dentistry to apply fluoride to the tooth surface. The use of topical fluoride is highly recommended for early childhood teeth because the enamel's resistance to acidic conditions can increase and prevent caries in children. In its use, of course, topical fluoride has indications and contraindications. Indications for the use of topical fluoride are sensitive teeth, the state of the root surface that has not completely closed perfect for young permanent teeth, in young children who have a moderate to high risk of caries, as well as children with special needs who find it difficult to clean their teeth and mouth independently, an example is a patient down syndrome and patients undergoing orthodontic treatment. On the other hand, contraindications to the use of topical fluoride are in patients with adequate fluoride intake, in children who are at low caries risk, patients with hypersensitivity or a history of allergy to fluoride, teeth with large cavity sizes, and patients who have lesions in the soft tissue around the teeth [5].

As previously explained, topical fluoride is said to be more effective if there is a combination of uses in its use. In this case, topical fluoride gel preparation with the Aloe Vera extract was used as a caries prevention measure in early childhood. Aloe Vera contains active substances such as saponins, tannins, alkaloids, glycosides, flavonoids, and minerals such as potassium, zinc, sodium, iron, copper, magnesium, phosphate, and manganese. Aloe Vera also has many benefits including antimicrobial, anti-inflammatory, and wound-healing effects. The reason why aloe vera is said to be effective in reducing caries and plaque is that aloe vera contains active substances such as flavonoids, anthraquinones, and saponins which have antibacterial abilities and can dissolve the lipoproteins present in the bacterial cell membrane so that the bacterial cell membrane becomes damaged and the function of the bacterial cell can be disrupted. A study also proves that *Streptococcus mutans* are the most sensitive bacteria to aloe vera so in vitro the ethanol extract of aloe vera is said to be 100% effective in inhibiting the growth of *Streptococcus mutans* after two days of incubation. Colonies cultured on aloe extract with a concentration of 18.75% decreased [18].

3.6. Mechanism of Action of Topical Fluoride with Aloe Vera Extract

There are three ways fluoride can exert its anti-caries effect in different work. Fluorapatite occurs on tooth structure and can be increased due to the presence of fluoride ions from phosphate ions and calcium ions present in saliva. In a similar procedure, new and non-cavitated carious lesions are remineralized. Fluoride also has antimicrobial activity.

Fluorine is divided into two different effects, namely topical and systemic effects. Topical fluoride preparations are varnish, SDF, gel, mouthwash, and toothpaste. Fluorine with systemic effect provides long-term protection against caries. Some examples of systemic effects of fluorine preparations are fluorinated formula milk, salt, supplements, and drinking water. Topical fluoride and systemic fluoride will work effectively if used together [19]. There are three stages of fluorine action, namely inhibiting the demineralization process in order to slow down the development of carious lesions, increasing the resistance of the tooth coating from acid attack and maximizing the remineralization process, and fluorapatite being formed from the reaction with hydroxyapatite [20].

Aloe vera's antimicrobial action is effective against various periodontopathic and carogenic microorganisms such as *Streptococcus mutans* that has a major role in the development of caries [15]. This effectiveness shows the use of aloe vera extract for the prevention of dental caries drug as well as a mouthwash [16]. Because it minimizes secondary caries and provides long-term successful restoration. Aloe vera leaves contain Acemannan, a D-isomer mucopolysaccharide in that indicates as a covering material for the pulp for primary teeth, because of its biocompatibility and promotes reparative dentin formation [21].

3.7. Time and Dosage for Topical Use of Fluoride with Aloe Vera Extract

Fluoride topical preparations used in this study were with using a gel prepared with aloe vera extract. The gel preparations used were 1.23% APF gel and 2% NaF gel. APF-type gel has a concentration of 12.300 to 12.500 ppm with a pH of 3.5. Contraindications to the use of this APF gel are patients with porcelain or composite restorations. This is because some of the filler particles in the material can dissolve. Meanwhile, the concentration used in the NaF gel was 9,000 ppm with a neutral pH. The use of this gel preparation will certainly not pose a risk to the restoration. The recommended usage time is adjusted to the patient's age, if the patient's age is less than 6 years and 6 years to 18 years, the application time is 4 minutes every 3 months. After 20 to 30 minutes of fluoride application, patients are advised not to rinse, drink and eat to obtain maximum results [19].

In its use, topical fluoride should not be used excessively. This is because it can cause fluorosis. Fluorosis is enamel hypomineralization that occurs due to the retention of the protein amelogenin by fluoride so that the enamel is unable to undergo maturation resulting in a porous outer surface and subsurface. Fluorosis can also cause discoloration of the enamel, which can range from opaque white patches to brownish. The level of fluorosis is divided into three, namely low levels, moderate levels, and high levels. If the patient has mild fluorosis, the enamel will only lose its light and when it is dried it will appear with opaque white spots. Meanwhile, in patients with high-grade fluorosis (TF 5-9), post-eruptive changes cause pit formation on the outside. Damage to the outer enamel will increase the risk of resistance to caries-related microbial deposits so damaged teeth will become more susceptible to caries [22].

3.8. Level of Effectiveness of Using Topical Fluoride with Aloe Vera Extract

Children at an early age who have a high risk of getting caries should do this treatment as soon as possible while doing prevention so that caries do not recur. One effective solution for caries prevention is through the topical use of fluoride. This is due to the antimicrobial effect that fluoride has, which is good for preventing caries [2]. From the results of a review article discussing the prevention of dental caries using local fluoride, it was stated that applying topical fluoride directly to the outer surface of the teeth is the right step in preventing caries. This is done to prevent bacteria from sticking to the outermost layer of the teeth or enamel so that further tooth decay can be avoided. Examples of using local fluoride are TAF, S-FMR, and tooth brushing, each of which has its benefits and effectiveness. Local fluoride application is generally done using a toothbrush with toothpaste every day. Apart from that, additional effective prevention efforts, namely TAF and S-FMR, can be carried out so that in the future caries do not occur. It is mandatory to use the correct dosage in order to avoid dental abnormalities or symptoms of poisoning. Should avoid using it in large doses so that it is absorbed for a certain period that it can threaten the health of the body.

The technique of selective caries removal from deep carious lesions using air abrasion has been reported in the literature [23]. provides more success in maintaining pulp vitality comparing with other techniques such as gradual, or non-selective removal [24]. Referring to this research, the success rate is higher when combined with the technique of using the aloe vera extract as an antiseptic for cavities.

4. Conclusion

Topical fluoride with aloe vera extract is one of the preventive steps in preventing caries and plaque. This preparation contains active substances such as flavonoids, saponins, and anthraquinones which have antibacterial abilities and can dissolve the lipoproteins contained in the bacterial cell membrane, causing the bacterial cell membrane to be damaged and the function of the bacterial cell to be disrupted. The use of topical fluoride with aloe vera extract can be used for 4 minutes every 3 months and not excessively because it can cause fluorosis. The use of topical fluoride in combination with aloe vera extract has a considerable success rate as a preventive action in preventing caries in early childhood due to growth. *Streptococcus mutans* became inhibited after two days of incubation period and the number of colonies cultured in aloe vera extract with a concentration of 18.75% decreased.

Compliance with ethical standards

Acknowledgments

All the authors recognized their equal contributions, reviewed the manuscript, and provided their approval.

Disclosure of conflict of interest

We confirm that there were no significant conflicts related to this article.

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