

Stop Caries with Povidone Iodine

Yetty Herdiyati¹, Eriska Riyanti², Diah Prastuti³, Prima Andisetyanto⁴

¹Universitas Padjadjaran, Faculty of Dentistry, Department of Pediatric Dentistry.
Sekeloa Selatan 1st, Bandung, West Java, Indonesia 40132

Abstract: Dental caries is local destruction of hard tissue of the teeth by acid from carbohydrate fermentation by bacteria. Defined as loss of mineral ion continuity on the crown or the root stimulated by oral bacteria and its biologic products. Povidone iodine is antimicrobially widely used in dentistry with broad spectrum activity. The purpose of this study was to determine the ability of povidone iodine in preventing caries. True experimental study on 60 lower anterior deciduous teeth soaked in artificial saliva enriched with *Streptococcus mutans* and 2% sucrose for 3 weeks *in vitro*, then evaluated clinically and microscopically using scanning electron microscope. Kruskal-Wallis non parametric test and Wilcoxon-Mann Whitney test used to evaluate the difference of caries inhibition between povidone iodine group and control group. Statistic test using Kruskal-Wallis test for clinical evaluation showed significant result with p -value 0,0020 ($\alpha < 0,05$) between control group and treated group, and for SEM evaluation showed not significant result with 0,0862 ($\alpha < 0,05$). Statistic test using Wilcoxon-Mann Whitney test showed there is significant clinical difference between control group and povidone iodine group, and control group. But there is no significant difference clinically and SEM between povidone iodine group and control group with $\alpha < 0,05$ (95%). Conclusion of this research is povidone iodine is effective to inhibit caries in *in vitro* study.

Keywords: caries, *Streptococcus mutans*, povidone iodine.

1. Introduction

In daily dentistry practice, caries is the most frequently found dental and oral disease. It needs a particular attention not only in curative but also in preventive measures.¹ The National Basic Health Research, based on a survey in 2013, shows that Indonesian children aged 12 years old have a DMFT index of 1.4. Bangka Belitung is the province with the highest DMFT of 8.5 and West Papua is the province with the lowest DMFT of 2.6. In a dental and oral check up to children aged 1-4 years old, 10.4 % experienced dental and oral problems, while for children aged 5-9 years old, the percentage is about 28.9 %. The percentage for children aged 10-14 years old is around 25.2 %. Data in the 2001 National Household Health Survey show that the people's motivation to get dental filling is still low, which is 4-5 %. Meanwhile, the percentage of dental decay that is not treated and needs dental filling or extraction is about 82.5 %. Thus, serious efforts to prevent declining DMFT score are needed.²

Caries is basically caused by dental plaques that contain various bacteria. The primary caries-causing bacteria in the dental plaque are *Streptococcus mutans*. *Streptococcus mutans* are bacteria that are involved in enamel demineralization. Repeat consumption of carbohydrates leads to increased population of *Streptococcus mutans* as well as increased organic acid and extracellular polysaccharide matrix formed by *Streptococcus mutans*. The polysaccharide produced by *Streptococcus mutans* becomes the bacteria intermediary to attach to the dental surface.³

Chemical caries control has been applied since the study performed by Miller in. The study estimated that antiseptic could kill bacteria, confined the amount of bacteria or bacteria activity. Antibacterial mouthwash has been used in preventive dentistry since many years ago. Antibacterial materials with wide spectrum are used to reduce biofilm accumulation or to destroy bacterium cell.⁴

Povidone iodine is an antiseptic material with a wide spectrum and has a high antimicrobial activity, low resistance potentials, and inexpensive. Povidone iodine has been used as an antimicrobial material in dentistry in 1-10 % concentration. It has been used as topical antiseptics in oral surgery, periodontal therapy, and it can also control new caries lesion incidence in children with a high caries risk. Povidone iodine works as a quick antibacterial material that penetrates into microorganism cell wall and influences enzyme structures and function along with cell protein. Povidone iodine also destroys bacterial cell function by preventing hydrogen binding, and changing the bacterial cell membrane structure.⁷

2. Povidone Iodine Mechanism In Inhibiting Caries

A study performed by Simratvir in 2010, the use of 10% povidone iodine in children with early childhood caries with an interval of 3 months for 1 year showed a significant decrease in *Streptococcus mutans* level. The decrease of bacteria level led to a decrease in caries recurrence in children who were the subjects in the study.¹⁵

Iodine is slowly released, enters bacteria cell surface, and then the cell membrane and deactivate cytoplasm protein, fatty acid and nucleotide of the bacteria. The slow release of iodine from povidone iodine complex functions to minimize iodine toxic effect to the cell.¹⁶ The iodine influences the protein structure by oxidizing the cysteine and methionine S-H bond, reacts to tyrosine and N-H amino acid, arginine, histidine, and lysine to block hydrogen binding. Iodine reacts to adenine, cytosine, and guanine to prevent the hydrogen binding and change the bacterial membrane structure. Iodine reacts to fatty acid in lipid membrane and change the membrane physical property until the cell wall leaks and cellular materials disappear.⁷

Adhesion inhibition of bacterial plaque is one of the

anticaries therapy targets . One of the bacterial virulence factors that causes caries is the ability to colonize on dental surface if there is sucrose in the diet. . The bacterial colonization process depends on glucan formation by extracellular GTF enzymes that plays a role in dental plaque formation and accumulation of acid resulting from bacteria metabolism that causes demineralization of teeth. Controlling bacteria colonization and plaque accumulation helps preventing GTF enzyme from functioning and increasing insoluble glucan production.^{17,18}

Plaque planktonic bacteria is more sensitive to iodine than non planktonic bacteria. Bacterial adhesion mechanism is mediated by extracellular polysaccharide formation and fructan produced by GTF and FTF enzymes. The reduction in GTF and FTF activities will lead to lower glucan and fructan production that will inhibit bacterial attachment to dental surface and bio film formation. Iodine inhibits GTF and FTF performance; hence, decreasing decreases glucan and fructan production.¹⁶ According to previous studies, the minimum lethal level of povidone iodine for *Streptococcus mutans* is 1% with a minimum contact time of 5 minutes.

Iodine has an ability to penetrate the bacterial cell wall very rapidly. Iodine molecule interacts with essential proteins, causing respiration enzyme amino acid component oxidation in bacterial cell membrane. Schreier et al. (1997) examines povidone iodine in microbial cells and found punctures in cytoplasm and bacterial nucleus coagulation. The puncture and coagulation change the structure and function of enzyme as well as the bacterial cell protein, leading to damages bacterial cell function.⁷

3. Methods

Sample in this study includes 60 deciduous lower anterior teeth soaked in artificial saliva containing media enriched by sucrose. *Streptococcus mutans* were added in the media to simulate cariogenic condition and cause caries to the sample. The roots of the teeth in the sample were cut using a diamond disc up to the dentocervical junction, cleaned from remained soft tissues, polished by water-mixed pumice, and rinsed until they were clean, then sterilized using autoclave. The samples were soaked in artificial saliva enriched with sucrose in an anaerobic condition in 37°C. The teeth were coated by nail polish in the lingual and proximal sides and a 3x3 mm area was left untouched in dental labial for caries process.

The sample was divided into 2 groups (30 teeth in control group, 30 teeth in povidone iodine groups). Each group were soaked in artificial saliva for 14 days and 21 days. Sample in povidone iodine group was polished by povidone iodine every 2 days to see differences in the effectiveness in inhibiting caries. After 14 and 21 days, the sample was retrieved from the media, dried and coated by gold coat to be examined under the scanning electron microscope (SEM) with 1,000 times magnification.

The formed caries was examined microscopically using SEM and the examination results were distributed in an ordinal

scale i.e. caries ordinal scale through SEM examination modified from Rajesh et.al¹⁹.

- 0 : no change on enamel surface.
- 1 : changes in the aprismatic surface of the enamel surface.
- 2 : porous enamel prism center with intact prism margin.
- 3 : total enamel surface erosion, as the cause for opened dentinal tubules.

4. Results

Scale	Table SEM Examination Result			
	Amount of sample in Group			
	Control		Povidone iodine	
	Day 14	Day 21	Day 14	Day 21
0	0	0	0	0
1	6	0	18	18
2	21	2	10	10
3	3	28	2	2

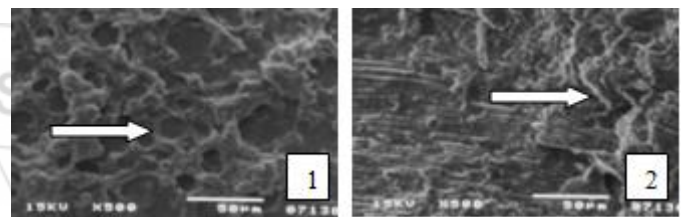


Figure 1: Control Sample SEM Image, 500 times Magnification
 Description: 1. 14 days control
 2. 21 days control

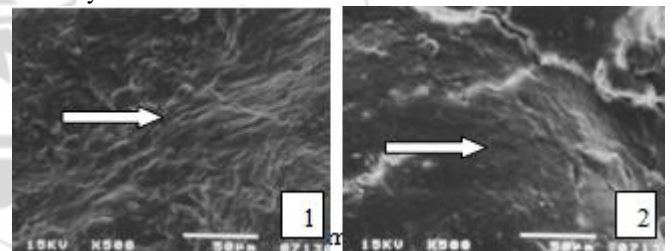


Figure 3: Povidone iodine Sample SEM Image with 500 times Magnification
 Description : 1. 14 days Povidone iodine
 2. 21 days Povidone iodine

5. Discussion

Caries is prevented mechanically and chemically. The effectiveness of mechanic caries prevention, such as brushing teeth and using dental floss, depends on individual motoric ability. The use of antibacterial material helps the effectiveness of mechanic caries prevention because it can reach the difficult-to-clean area of the teeth.²⁰

Caries in this study was formed because the artificial saliva in which the teeth were soaked experienced a pH decrease during the incubation from about 7-8 on the first day to 4-5 on the third day. The caries was formed because of enamel crystal destruction caused by acid sucrose metabolism production by *Streptococcus mutans*. As stated by Marsh and Nyvad, acid production by bacteria and environment condition around the teeth under critical pH (under 5.5) will proceed to enamel demineralization.²¹

The SEM examination in the 14th day on the control teeth and povidone iodine teeth presents porosity of the enamel because the enamel crystals were dissolved. In the SEM examination, the sign of dissolution on the outer enamel surface and dilatation of intercrystallin space indicate the dissolution of half of enamel crystalized surface. The dissolution of hydroxyapatite crystal and enamel phosphate calcium depends on the environment pH around the enamel. 22

According to the SEM examination, the damages of the teeth with povidone iodine application stopped in 14 to 21 days. The porosity in dental enamel that received povidone iodine application did not increase much and no widening was found. Povidone iodine penetrating the demineralized enamel porosity kills the cariogenic bacteria, and decreases the production of bacterial acid that is able to dissolve enamel; therefore, the dissolution of the enamel crystal stops. Caufield in his study stated that the application of 2% povidone iodine as the prophylaxis in 3 to 5 days of use in patients aged 13-17 years old decreases the amount of *Streptococcus mutans* colony in the saliva. 24

Povidone iodine has an antibacteria potential and ability to kill bacteria in a short period leading to less possibility of resistance; hence, povidone iodine can be used as a caries prevention alternative material. 25 Povidone iodine is able to inhibit the growth of *Streptococcus mutans* as the bacteria that cause caries with a low concentration (0.3%). Povidone iodine has a small molecular size so it can easily penetrate the enamel porosity and is also still effective in lower pH. 15 In addition, povidone iodine has a lower toxicity so it is safe to use inside the oral cavity even for the children. 26 Equalize the length of your columns on the last page. If you are using *Word*, proceed as follows: Insert/Break/Continuous.

6. Conclusion

Povidoneiodineshas a strong antibacteria characteristic and has a high effectivity in inhibiting the caries. Povidone iodine can be an alternative anticaries material because it has low toxicity, low price and can easily be obtained.

References

- [1] McDonald RE, Avery DR, Stookey GK. Dental caries in children and adolescent. Dalam McDonald RE, editor. *Dentistry for the children and adolescent*. Mosby. 2004. h 203-235.
- [2] BadanPenelitiandanPengembanganKesehatanKementrianKesehatan RI. Laporan Nasional RisetKesehatanDasar 2013. Diunduhdari www.litbang.depkes.go.id/launch_riskesdas tanggal 27 April 2014.
- [3] Manton D, Drummond BK, Kilpatrick N. Dental caries. Dalam Cameron AC, Widmer RP Editor. *Handbook of pediatric dentistry*. 3rd edition. Mosby Elsevier.2008. Hal 39-41.
- [4] Scheie AA, Petersen FC. Antimicrobials in caries control. DalamFejerskov O, Kidd E. Editor. *Dental caries. The disease and its clinical management*. 2nd edition. Blackwell Munksgard. 2008. Hal 266-271.

- [5] Sibbald RG, Leaper DJ, Queen D. Iodine made easy. *Wounds International* 2011 Volume 2 Issue 2.
- [6] Simratvir M, Singh N, Chopra S, Thomas AM. Efficacy of 10% povidone iodine in children affected with early childhoodcaries:an in vivo study. *ClinPediatr Dent*. 2010;Spring:34(3):233-8.
- [7] Furiga A, Dols-Lafargue M, Heyraud A, Chambat G, Lonvaud-Funel A, Badet C. Effect of antiplaque compounds and mouthrinses on the activity of glucosyltransferases from *Streptococcus sobrinus* and insoluble glucan production. *Oral MicrobiolImmunol* 2008;23:391-400.
- [8] Anderson MJ, Horn ME, Lin YC, Parks PJ, Peterson ML. Efficacy of concurrent application of chlorhexidine gluconate and povidone iodine against six nosocomial pathogens *Am J Infect Contr* 2010;38:826-31.
- [9] Kumar J, Jayachandran E, Hemanth KRC, Gunashakaran V, Ramesh Y, Kalayan BP, et al. Application of broad spectrum antiseptic povidone iodine as powerful action: a review. *J of Pharm Sci Tech*.2009.vol 1(2);45-48.
- [10] McIntyre JM. Dental caries- the major cause of tooth damage. Dalam: Mount GJ, Hume WR. editor. *Preservation and restoration of tooth structure*. 2nd edition. Knowledge Books and Software; 2005. h 21.
- [11] Caufield PW, Griffen AL. Dental caries: an infectious and transmissible disease. *PediatrClin North Am* 2000;47(5):1001-20.
- [12] Gebaska A, Kedzia A, Kochanska B, Wasek A, Kwapisz E, Bottenberg P. Effectiveness of incipient caries induction in microaerophilic and/or aerobic conditions using *Streptococcus mutans* and *Lactobacillus acidophilus*. In vitro studies. *J Stoma* 2012;65,3:344-358.
- [13] Ten Cate JM, Larsen MJ, Pearce EIF, Fejerskov O. Chemical interaction between the tooth and oral fluids. DalamFejerskov O, Kidd E. editor. *Dental Caries The Disease and its Clinical Management*. 2008. Blackwell Munksgard. h 210-213.
- [14] Berkowitz RJ, Koo H, McDermott MP, Whelehen MT, Ragusa P, Kopycka-Kadzieraswki DT et al. Adjunctive chemotherapeutic suppression of Mutans Streptococci in the setting of severe early childhood caries : An Exploratory Study. *J of Public Health Dent* 2009 vol 69 no 3:163-167.
- [15] Robinson C, ShoreRC, BrookesSJ, StraffordS, WoodSR, Kirkhamet J. The chemistry of enamel caries. *Grit Rev Oral Biol Med 1 Crit Rev Oral Biol Med* 2000;11(4):481-495.
- [16] Sunil Kumar P, Raja Babu P, Jagadish Reddy G, Uttam A. Povidone Iodine –Revisited. *IJDA* 2011;3(3), July-September.

Author Profile



Yetty Herdiyati (Indonesia) received DDS from Universitas Padjadjaran in 1979. She continued to specialist program in Pedodontics in Universitas Padjadjaran and graduated in 1995. She finished her doctorate degree from Universitas Padjadjaran in 2007. She is a lecturer in Department of Pediatric Dentistry of Universitas Padjadjaran.



Eriska Riyanti (Indonesia) received DDS from Universitas Padjadjaran in 1994. She continued to specialist program in Pedodontics in Universitas Padjadjaran and graduated in 2003. She finished her doctorate degree from Universitas Padjadjaran in 2010. She is a lecturer in Department of Pediatric Dentistry of Universitas Padjadjaran.



Diah Prastuti (Indonesia) received DDS from Universitas Padjadjaran in 2003. She continued to specialist program in Pedodontics in Universitas Padjadjaran and graduated in 2014.



Prima Andisetyanto (Indonesia) received the DDS degrees from Universitas Padjadjaran, Bandung, Indonesia in 2012. He is a lecturer in Department of Pediatric Dentistry of Universitas Padjadjaran from 2014 until present.

