

EFFECT OF CHEWING POLYOLS GUMS ON THE ACCUMULATION OF DENTAL PLAQUE AROUND ORTHODONTIC BRACKETS

(EFEK MENGUNYAH PERMEN KARET POLYOL TERHADAP AKUMULASI PLAK DI SEKITAR PERLEKATAN BRAKET)

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Abstract

This study aimed to investigate the effect of xylitol compared to sorbitol as polyols chewing gum on the plaque accumulation during treatment with fixed orthodontic appliances. This clinical trial comprised 20 healthy orthodontic patients aged 18 –to-30-years old. The subjects were randomly assigned into 2 groups: xylitol group (n=10) and sorbitol group (n=10). The subjects were instructed to chew 2 pieces of tested chewing gum three times everyday for a 14-days period of experiment. The xylitol gum contained of 1300 mg xylitol per serving (2 pieces of gum) while the sorbitol gum was sweetened with sorbitol. At baseline and after 14 days the plaque were collected from bucco-cervical surfaces around brackets of premolar and front teeth and then dried weigh. The result of this study showed that the means of plaque weight in the xylitol group at baseline and after 14 days were 2.75 mg \pm 2.59 mg and 0.92 mg \pm 1.23 mg respectively, while the means of plaque weight in the sorbitol group at baseline and after 14 days were: 2.13 mg \pm 0.94 mg and 2.37 mg \pm 0.89 mg respectively. After one way ANOVA and post hoc test, there was no difference between plaque weight in both groups at baseline (p=0.2) while the plaque weight in the xylitol group was significantly lower than the sorbitol group after 14 days (p < 0.01). In conclusion, 14-days use of xylitol-containing chewing gums, corresponding to a daily amount of 4 grams of xylitol, could eliminate the plaque accumulation in fixed orthodontic patients.

Key words: xylitol gum, plaque accumulation, orthodontic bracket

INTRODUCTION

One of the problems encountered in an orthodontic treatment is the maintenance of patient's oral hygiene. Brackets used in fixed orthodontic treatment increase the risk of dental plaque accumulation. Disposition of dental plaque in fixed orthodontic treatment is primarily due to the bracket's elaborate anatomy.¹ Fixed orthodontic appliances, with ineffective oral hygiene, can result in increased oral plaque accumulation and increase the risk of white-spot lesion that will lead to dental caries.²

Sucrose is one of dietary factors of dental caries development. Excessive sucrose intake may suppress the buffer capacity of the saliva, hence the increasing risk of dental caries. This is due to the rapid synthesis of sucrose extra cells; faster than that of

other sugar, e.g. glucose, fructose, and lactose, thus the shorter time span required until being rendered acidic by oral cavity microorganisms.³

One such class of sucrose substitutes known as "polyols" or "sugar alcohols" is nonfermentable sugar. The most common polyols are sorbitol and xylitol, and they have been used extensively as sugar substitutes in chewing gum.⁴

Numerous clinical studies have shown that consumption of xylitol that can be significantly reducing plaque accumulation.⁴ Another common sugar substitute is sorbitol, which is six carbon polyol. Sorbitol is most frequently added to food, both in solid and in liquid form. It is cheaper than xylitol but its sweetness is only 50 per cent that of sucrose or xylitol.⁵ Sorbitol is metabolized in the same manner as xylitol, however, the major difference between

sorbitol and xylitol is that sorbitol can be fermented by *Streptococcus mutans*. Although acid production can occur during sorbitol metabolism by the bacteria, the rate is significantly slower than that of other dietary sugar such as sucrose, glucose and fructose.⁵

In the study of 11- to 15-year-old children wearing fixed orthodontic appliances and who chewed gum with a maximum of 10.5 g xylitol/day for 28 days, reported a significant reduction by 43% to 47% of plaque accumulation.⁶ However, a dose response study indicating that exceeding the daily dose of xylitol 10.32 g/day is not likely increase effectiveness and alternatively, a dose of 3.44 g/day is not likely show reductions in *Streptococcus mutans* levels.⁷

This study aimed to investigate the effect of xylitol compared to sorbitol as polyols chewing gum on the plaque accumulation during treatment with fixed orthodontic appliances.

MATERIALS AND METHODS

Twenty healthy fixed orthodontic patients aged 18- to 30-year-old were invited to participate in this study. They were treated using fixed orthodontic appliance at Department of Orthodontic, Trisakti University Dental Hospital, Jakarta, Indonesia. They were then randomly divided into xylitol (n=10) and sorbitol (n=10) groups. All of the participants have four extracted bicuspid according to the orthodontic treatment. Participants were well informed about the study and signed the informed consent form. The study protocol was approved by the Faculty of Dentistry, Trisakti University Ethic Committee.

The subjects were instructed to chew 2 pieces of the test chewing gum 3 times every day for a 14 days period. The xylitol chewing gum contained of 1310 mg xylitol per serving (2 pieces of gum) while the sorbitol chewing gum was sweetened with sorbitol. Using periodontal curette instrument (Columbia 13-14) the fresh dental plaque was collected at baseline and after 14 days from incisors, canines and premolars from the area between gingival margin

and the bracket. The fresh plaque samples were then placed in an incubator with 35°C temperature for 6 days. Data was weighed as dry weight of the plaque samples using weighing pan (Mettler analytical balance).

RESULTS

All 20 randomized participants completed the study. The mean of participants aged was 22.6 ± 3.6 yrs (range 18 to 30), with 13 females and 7 males. The means of dry weight plaque in the xylitol and sorbitol group at baseline were 2.75 ± 0.67 mg and 2.13 ± 0.94 mg respectively. The means of dry weight plaque in the xylitol and sorbitol group after 14 days were 0.92 ± 0.23 mg and 2.37 ± 0.89 mg respectively (Figure 1). Data was normally distributed ($p > 0.05$). The significant result for homogeneity of variance was 0.06, which showed that the error variance of the dependent variable is equal across the groups, i.e. the assumption of the ANOVA test has been met. The result of one way ANOVA and post hoc test showed that, there was no difference between plaque weight in both groups at baseline ($p = 0.2$) while the plaque weight in the xylitol group was significantly lower than the sorbitol group after 14 days ($p < 0.001$).

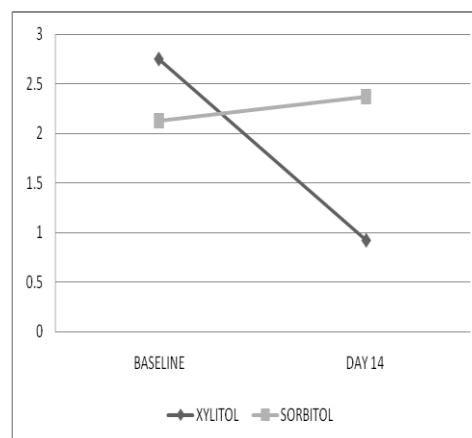


Figure 1. The trend of plaque weight (mg) from baseline and day 14

Table 1. One way analysis of variances of plaque weight

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	19.20675	3	6.40225	11.71917	0.00002	2.866266
Within Groups	19.667	36	0.546306			
Total	38.87375	39				

DISCUSSION

During the past 5 decades, clinical studies as well as laboratory studies have clearly demonstrated that sugar intake plays a major role in the pathogenicity of dental caries.⁸ Data collected from *in vivo* and *in vitro* studies indicated that sugar substitutes exhibited potential anti-caries effect in several aspects including inhibition of insoluble glucan synthesis from sucrose.⁴ The ability of *Streptococcus mutans* to produce extracellular glucans is responsible in the formation of dental biofilms or plaque accumulation.⁵

Researcher found that regular use of polyol-containing chewing gums could play a role in preventing caries by increasing salivary flow through mastication, reversing decreases in plaque pH and enhancing remineralization of subsurface enamel lesions.^{9,10} One of the most extensively studied sugar substitute is xylitol. Xylitol is a five carbon sugar alcohol that looks and tastes like sucrose. Xylitol can not be utilized and fermented by mutans streptococci or other microorganisms in oral cavity,⁴ but it can be directly absorbed by human small intestine and subsequently metabolized.⁵ It was found that xylitol has a bacteriostatic effect on *Streptococcus mutans* by creating a futile cycle that consumes cellular ATP.⁹ In a futile cycle, xylitol is transported across bacteria cell membrane by a phospho-transferase system, generating xylitol-5-phosphate which can not be metabolized and may subsequently be dephosphorylated and exported at the expense of ribitol-5-phosphate.¹⁰ Numerous clinical studies have shown that consumption of xylitol can be significantly reducing plaque accumulation.⁶ Xylitol chewing-gum seems to be a promising measure for dental caries prevention, a dose-response relationship is still in urgent need for the establishment of a xylitol based therapy against dental caries, especially when there are cases where xylitol failed to show caries reduction effect at lower doses.¹¹

Dental plaque is defined as the soft adherent structured deposits, which forms upon a sticky layer known as glucan which is produced by mutans streptococci on the teeth surfaces. Evidence suggests that consistent use of xylitol-sweetened gum reduces plaque accumulation.⁸ A substantial body of literature suggests that a minimum of 5 to 6 grams and 3 exposures per day from chewing gum or candies are needed for a clinical effect to be achieved.¹² However, there is still conflicting evidence in the literature about the dose in using xylitol chewing gum. Xylitol at 6.88 g/day and 10.32 g/day reduced *Streptococcus mutans* in plaque at 5 weeks, and in plaque and saliva at 6 months.⁷ Previous study re-

ported that there were no changes in *Streptococcus mutans* counts in plaque or saliva after the use of xylitol lozenges at doses of 1.7 g/day and 3.4 g/day for 18 weeks.¹³ In this recent study we observed the plaque accumulation after 14 days using of xylitol chewing gum at 4 g per day. The results of this current study showed that a dose of 4 g xylitol chewing gum per day was significantly reduced plaque accumulation compared with an identical chewing gum containing sorbitol. Relatively large amounts of xylitol (for example, 7-14 grams per day) can be consumed without untoward side effects, though when ingested in quantity they can act as a laxative.⁴

Most of previous clinical studies have chosen chewing gums as the carrier for xylitol, and since frequent chewing is also proven to protect against caries by stimulating saliva flow,⁴ proper control groups such as sugar-free gum group but not no-gum-chewing group should be used to rule out other factors that might affect caries experience. In our study we use sorbitol group as the control group. Corresponding to rule out the factors that might affect plaque accumulation, in this study we used the sorbitol chewing gum in the same size, taste and texture with the xylitol gum.

In this present study dental plaque was found less formatted after two weeks regularly chewing xylitol gum. It seems that this clinical findings are according to the laboratorically findings that biofilm or dental plaque was less formatted in the presence of xylitol.⁹

One of the problems encountered in an orthodontic treatment is the maintenance of patient's oral hygiene. The demineralization of enamel adjacent to orthodontic brackets is a significant clinical problem.¹⁴ Brackets used in fixed orthodontic treatment increase the risk of dental plaque accumulation.³ Disposition of dental plaque in fixed orthodontic treatment is primarily due to the bracket's elaborate anatomy. Enamel demineralization in an orthodontic treatment is a rapid and continuous cariogenic process resulting from plaque maturation around the brackets. White lesion found around the brackets is a major esthetic issue in an orthodontic treatment.² The using of glass ionomer containing brackets bonding material have been proposed through *in vitro* studies to provide preventive actions against demineralization of enamel adjacent to orthodontic brackets.^{1,14}

Clinical studies using xylitol as caries preventive agent in fixed orthodontic patients have been done in several dependence times^{3,6,13} However, the application of those clinical findings in clinical improvement in fixed orthodontic treatment have not

been developed yet. It's supposed that there is no strong evidence about the concentration and frequency required for clinical benefit. So far there is only one study aimed to determine the relationship between dose and effect of xylitol chewing gum on streptococci mutans.⁷ A plateau effect is suggested between 6.44 g and 10.32 g xylitol/day. It can be assumed that 6.44g xylitol/day is the minimum concentration required for clinical benefit.

A five-week randomized controlled trial was conducted to determine the reduction in *Streptococcus mutans* levels in plaque and unstimulated saliva to increased frequency of xylitol gum use at a fixed daily dose of 10.32 g.¹⁵ All of 132 participants received either 10.32 g xylitol/day in the active group or 9.83 g sorbitol or 0.7 g maltitol per day in the control group. The 10.32 g dose was used because it would be clearly allowing the hypothesis to be tested, even though a smaller dose (e.g., 6.88 g) might also have been possible. The number of pieces of gum did not change, and frequency of chewing (times per day) varied from 2 to 4 times/day within the active group; the control group chewed gum 4 times/day. There were no significant differences in *Streptococcus mutans* levels among the groups at baseline. At 5 weeks, there was a linear reduction in *Streptococcus mutans* in plaque and unstimulated saliva to increasing frequency of xylitol gum use at a constant daily dose of 10.32 g. In a clinical study among school age children aged 12-to-15-years old xylitol chewing gum was compared with sugar sweetened chewing gum on the ability to eliminate the inter dental plaque pH. The children were instructed to chew 2 pieces of the test chewing gum 3 times every day for a 28 days period. The xylitol chewing gum contained 1310 mg xylitol per serving (2 pieces of gum) while the control chewing gum was sweetened with sucrose. After 28 days the interdental plaque pH was significantly higher compared to the control group and baseline.¹⁶ In this recent clinical trial we used the same xylitol dose regimen, 4 grams xylitol per day divided into the same frequency, three times per day.

It can be concluded that 14-days use of xylitol-containing chewing gums, corresponding to a daily amount of 4 grams xylitol and divided into three times chewing per day, could eliminate the dental plaque accumulation in patients with fixed orthodontic appliance.

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