10.21608/ADJC.2023.176866.1205 Advanced dental journal
Volume 5 (2023) | Issue 4| Pages 955-965

Original Article

Evaluation of caries preventive potential of preventive regimens containing herbal-based or fluoride-based toothpastes versus fluoride varnish and fluoride toothpaste only in high caries risk patients: randomized clinical trial

Hoda Abdelmeguid Sabry[1], Rawda Hesham A.ElAziz[2], Mona Ismail Riad[2]
[1]Department of conservative and Restorative dentistry, Faculty of Dentistry, Galala University.

[2]Department of conservative dentistry, Faculty of Dentistry, Cairo University

Email: rawda.hesham@dentistry.cu.edu.eg

Submitted: 4-12-2023
Accepted: 13-5-2023

Abstract

Aim: This study was conducted to assess the caries preventive effect of different preventive regimens using herbal toothpaste compared to fluoride toothpaste and fluoride varnish on high caries risk patients.

Materials and methods: A three-armed, parallel-groups, randomized, controlled trial was conducted on 54 participants with high caries risk. Participants were randomly allocated into three groups, (Himalaya complete care), fluoride toothpaste (signal) and fluoride toothpaste (Signal) and fluoride varnish (Polimo). Cariogram assessment was done in four intervals: T0: baseline, T1: after one week, T2: after four weeks and T3: after 12 weeks. Data was analyzed using Medcalc software, version 19 for windows (MedCalc Software Ltd, Belgium). A value less than or equal to 0.05 was considered statistically significant and all tests were two tailed.

Results: Regarding caries risk, Intergroup comparison have shown no statistically significant difference within different follow up periods. Intragroup comparison has shown statistically significant difference between different follow-up periods ($P < 0.0001$).

Conclusion: In high caries risk patients, caries preventive regimen based on herbal toothpaste has similar clinical performance to those based on fluoride toothpaste and varnish along three months' follow-up.

Clinical significance: In high-caries-risk individuals, preventive regimens comprising various toothpastes have a favorable impact on caries prevention.

Keywords: High caries risk patients ; herbal toothpaste ; fluoride toothpaste ; fluoride varnish ; preventive regimen

1.Introduction

Dental caries is one of the most prevalent oral diseases that is usually seen in various ages. In the progress of this disease, several microorganisms, such as Streptococcus mutans (SM), and lactobacillus (LB) have an important part in carbohydrate fermentation leading to the production of lactic acid which leads to the demineralization of enamel

[1]. Caries has always been treated by looking for cavitation on the tooth surface. However, it is now widely accepted that a caries management protocol that focuses solely on surgical approach while ignoring the risk factors that cause the disease will eventually result in the appearance of new carious lesions and treatment failure. Hence, Caries risk assessment (CRA) should be an important aspect of any caries management protocol [2].

Thus, crucial preventive measures should be applied for high caries risk patients. Application of fluoride compounds topically; is one of these measures; it produces accumulations of calcium fluoride (CaF2) on the surface of enamel. Fluoride varnishes (FV) stay on the surface of the tooth for a longer time and gradually release fluoride into the oral cavity [3]

Herbs have been utilized aiming to avoid dental diseases. Herbal toothpaste has the ability to decrease the incidence of dental caries by the means of the shared effects of antibacterial agents, oral acid neutralizers and the bacterial enzyme inhibitors that are found in those toothpastes [4].

In order to prevent dental caries, xylitol has been recommended. Xylitol possesses three features which idealize its usage as a mean of prevention. Firstly, xylitol is not fermented easily by oral bacteria such as streptococci; second, it has been demonstrated to decrease the number of S. mutans in the oral cavity and finally has the ability to induce the production of salivary enzymes, resulting in bacterial plaque growth inhibition [5].

Up to our knowledge, there have been no clinical studies evaluating the caries preventive effect of this herbal based toothpaste (Himalaya complete care) utilizing cariogram, so this study was performed aiming to evaluate the caries preventive effect of different preventive regimens using herbal or fluoride toothpastes compared to fluoride varnish and fluoride toothpaste only in addition to sugar free gum containing xylitol on the level of high caries risk patients. The research hypothesis tested was there was no difference between the caries preventive effect of herbal or fluoride-based toothpaste and fluoride varnish.

2.Materials and Methods

This study was registered in (www.clinicaltrials.gov) with I.D: NCT04436913. The study was approved by the Research Ethics Committee (CREC), Cairo university with approval number 23 / 7 / 20.
All materials used in this study as well as their active ingredients, lot number and manufacturer are listed in Table (1).

Table (1): Materials' specification, composition, manufacturer and lot number

Material	Active ingredients	Lot number	Manufacturer
1.1. Himalaya® complete care toothpaste.	Miswak, Neem, Pomegranate and Babool and calcium fluoride	083 Exp. Date: 09/2023	Himalaya wellness company – India https://himalayawellness.in/products/complete-care-toothpaste United Arab Emirates By: SCITRA
1.2. Signal® toothpaste (cavity fighter)	Sodium Monofluorophosphate 1450 ppm Fluoride	73 Exp. Date:20/02/2023	Egypt Trademark: © Unilever England
1.3. Polimo® Fluoride varnish	5% sodium fluoride.	20065	Imicryl dental (Istanbul) https://www.imicryl.com/polimo-fluoride-varnish_76_u_en.html
1.4. Trident® sugar free gum	Sorbitol, gum base, xylitol, glycerine, natural and artificial flavors	10/2022	MONDELEZ GLOBAL LLC, mondelez international group, USA

2.1. Sample size calculation

A power analysis was designed to have adequate power to apply statistical test of the research hypothesis. A total of 54 (35 female and 19 male) participated in this clinical study. The predicted sample size (n) was a total of (43). Sample size was increased by (20%) to account for possible dropouts during follow-up

intervals to be total of (54) cases i.e. (18) for each group [3]. Sample size calculation was performed using G*Power 3.1.9.2.

2.2. Study Design

This three-armed, parallel-design, and randomized clinical trial study was conducted in the clinic of Conservative Dentistry Department, Faculty of Dentistry, Cairo University, Egypt. Randomization was done using simple randomization by generating numbers from 1:54 into three columns according to interventions/Control assessment methods. Each participant chose a random number from an opaque sealed envelope. The allocation sequence was generated using (www.randomization.com). It was a triple blinded study where the patients, data analyzer and the outcome assessors were blinded where all toothpastes were sprayed with black paint with allocation ratio 1:1:1.

The study was conducted over a period of 12 weeks, with a total of four visits: first visit (baseline: T0), second visit (1 week: T1), third visit (4 weeks: T2), and final visit (12 weeks: T3). The visits were arranged at the same time of day for each individual. Preceding each visit, the patients were asked to avoid tooth brushing and all other oral hygiene measures 24 h in advance and not to eat or drink anything but water for 1 h before the visit.

2.3. Before Intervention

2.3.1. Clinical Examination

Carious defects, fillings, and missing teeth were diagnosed, and DMFT (decayed, missing, and filled teeth index) scores were calculated according to WHO guidelines. Clinical examination was made using a plane mirror, and explorer without applying any pressure with the aid of a dental chair light on dried teeth. The assessed Decayed – Missing – Filled Teeth (DMFT) index score was entered into the cariogram software according to the codes given in the cariogram manual. Scores were given according to reference values presented by cariogram according to age.

2.3.2. High-Risk Group

Fifty-four subjects were evaluated to be at high caries risk according to the cariogram. The Inclusion Criteria (1) Healthy patients with free medical history. (2) Age range 30-50 years. (3) Patients with high caries risk assessment. The exclusion criteria for the patients were (1) Patients with a compromised medical history. (2) Extreme plaque accumulation and periodontal problems (3) Patients on any antibiotics during the past month. Six subjects were excluded from the study. Finally, 54 patients (19 males and 35 females) were recruited with 10 lost to follow-up at the end of the trial.

All carious teeth were filled with suitable restorations also scaling and polishing for each patient was done. Each patient received the same instructions regarding oral hygiene measures, provided with toothbrushes and dentifrice according to the tested regimen. They were instructed to brush their teeth with the allocated toothpaste with the modified stillman technique and floss their teeth prior to bedtime with non-fluoridated dental floss. In addition to chewing sugar-free gum (with xylitol), where the patients were requested to chew one xylitol chewing gum for five minutes 3 times per day (after meals) throughout the 12-week period.

Polimo fluoride varnish (FV) was applied to the control group at baseline visit only. The individuals' teeth were first brushed using a toothbrush. Second, cotton rolls were used to eliminate excess saliva and FV was applied to all tooth surfaces. After the varnish was applied, individuals were told not to clean their teeth or eat for at least 4 hours, soft food and liquids may be taken throughout this period.

2.4. Intervention

2.4.1. For intervention group A1:
Participants used herbal toothpaste containing "Neem, Miswak, Babool and Pomegranate" (Himalaya Complete Care) (Himalaya wellness company – India).

2.4.2. For intervention group A2:
Participants used fluoride-based toothpaste (Signal®) (© Unilever England), (1450 ppm sodium fluoride).

2.4.3. For Control group A3:
Participants used fluoride-based toothpaste (Signal®) and Polimo fluoride varnish (Imicryl dental®) was applied at baseline visit

2.5. Saliva Sampling Summary

Samples were collected in the morning between 9 and 12 am under standardized conditions. The patient sat down in an up-right position and was given a paraffin pellet in order to chew for 30 seconds, then spit out the collected saliva or swallow it. The participant then continued to chew it for five minutes, with the accumulated saliva collected unceasingly

into a test tube that is graduated in milliliters and the saliva secretion rate was expressed as milliliters per minute (mL/min). The collected stimulated saliva samples were also used for measuring buffer capacity. Salivary pH was measured using a strip (mcolorpHast pH Test strips, MilliporeSigma™) [6].

2.6. Creating a Risk Profile Using Cariogram

A caries risk profile of each individual was obtained at each of the four visits using Cariogram software. For each subject, the following ten caries-related variables were put into the Cariogram software: (1) caries experience, (2) related diseases, (3) diet content, (4) diet frequency, (5) MS count, (6) amount of plaque, (7) fluoride program, (8) salivary buffer capacity, (9) saliva secretion rate, and (10) clinical examination. Based on the entered variables, the chance of avoiding caries in the future was calculated. Country/area was set at normal, and the group was high risk for all subjects. The plaque index of six teeth (16, 12, 24, 36, 32, and 44) was evaluated using Silness and Loe's scale. The gathered data was documented and entered in the cariogram software using the codes given in the cariogram manual. For all individuals in the present study, the "clinical judgment" factor was given a score of one. Streptococcus mutans colony count was performed by using standard bacteriological culture methods. The collected salivary samples were diluted then cultured in the freshly prepared selective media (Mitis Salivarius agar) petri plates using glass rods, then these dishes were placed in candle jar and incubated at temperature of 37°C for 24 hours. A stimulated saliva sample was used during the evaluation of bacterial count as it was shown that they can show threefold than that revealed with unstimulated salivary samples [7].

Diet content was done through taking thorough diet content history (quality of diet) and the proper score was given according to the program where score 0=Very low fermentable carbohydrate, extremely good diet from caries perspective. Exposure to sugar only once in a day. 1=Low fermentable carbohydrate, appropriate diet, exposure to the sugar twice in a day. 2=Moderate fermentable carbohydrate, relatively high content of sugar. Exposure to sugar thrice in a day. 3=High fermentable carbohydrate, inappropriate diet, exposure to sugar > 3 times in a day.

Finally, the caries risk profile for each participant was obtained as a pie chart with five colored sectors, which showed the chance of avoiding caries as a percentage. According to these percentage values, all subjects were scored into three modified groups (high [H]: 0–30%, medium [M]: 31–60%, low [L]: 61–100%) from the highest to the lowest predicted risk group

2.7. Statistical Analysis

Data was analyzed using Medcalc software, version 19 for windows (MedCalc Software Ltd, Ostend, Belgium). Data was explored for normality using Kolmogrov Smirnov test and Shapiro Wilk test. Continuous data showed normal distribution and were described using mean and standard deviation. Intergroup comparison between continuous data was performed using one-way ANOVA, while intragroup comparison was performed using repeated measures ANOVA and two-way ANOVA was used to test interaction of variables followed by a tukey post-hoc test. Categorical data was described as frequency and percentage, comparisons between categorical variables were performed using the chi square test. A value less than or equal to 0.05 was considered statistically significant and all tests were two tailed

3.Results

3.1. Demographic data

Demonstrated in table (2) and (3)

Table (2): Gender distribution among groups:

Gender	Herbal-based toothpaste regimen (Himalaya Complete Care®).	Fluoride-based toothpaste regimen (Signal®)	Fluoride-based toothpaste (Signal®) and Polimo® fluoride varnish regimen	Total
Males	4 (22.2%)	7 (38.9%)	8 (44.4%)	19
Females	14 (77.8%)	11 (61.1%)	10 (55.6%)	35
Total	18	18	18	54

Table (3): Mean age among groups

Age	Herbal-based toothpaste regimen (Himalaya Complete Care®).	Fluoride-based toothpaste regimen (Signal®)	Fluoride-based toothpaste (Signal®) and Polimo® fluoride varnish regimen	Mean age of current trial
Mean age	31.5±7.7 years	30.3±8.5 years	32.7±6.4 years	31±7.5 years

3.2Progression of caries risk in patients:

Intergroup comparison between both materials have shown no statistically significant difference within different follow-up periods; baseline, 1 week, 1 month, and 3 months respectively (P = 1.0000, P = 0.4631, P = 0.5113 and P = 0.9775). Intragroup comparison within intervention 1 or intervention 2 or control have shown statistically significant difference between different follow-up periods (P < 0.0001). Table (4) and Figure (1)

Table (4): Frequency and percentage for high, moderate and low risk patients for the intergroup comparison between materials within each follow-up and intragroup comparison within each material between different follow-up periods

Material / Follow up	**Intervention 1**			**Intervention 2**			**Control**			
	High risk	Moderate risk	Low risk	High risk	Moderate risk	Low risk	High risk	Moderate risk	Low risk	
Baseline	18 (100%)	0 (0%)	0 (0%)	18 (100%)	0 (0%)	0 (0%)	18 (100%)	0 (0%)	0 (0%)	P = 1.0000
1 week	0 (0%)	13 (81.2%)	3 (18.8%)	0 (0%)	14 (93.3%)	1 (6.7%)	1 (6.6%)	13 (86.7%)	1 (6.6%)	P = 0.4631
1 month	0 (0%)	2 (13.3%)	13 (86.7%)	0 (0%)	1 (6.7%)	14(93.3%)	0 (0%)	3 (21.4%)	11 (78.6%)	P = 0.5113
3 months	0 (0%)	0 (0%)	15 (100%)	0 (0%)	0 (0%)	15 (100%)	0 (0%)	0 (0%)	14 (100%)	P = 0.9775
P value	P < 0.0001*			P < 0.0001*			P < 0.0001*			

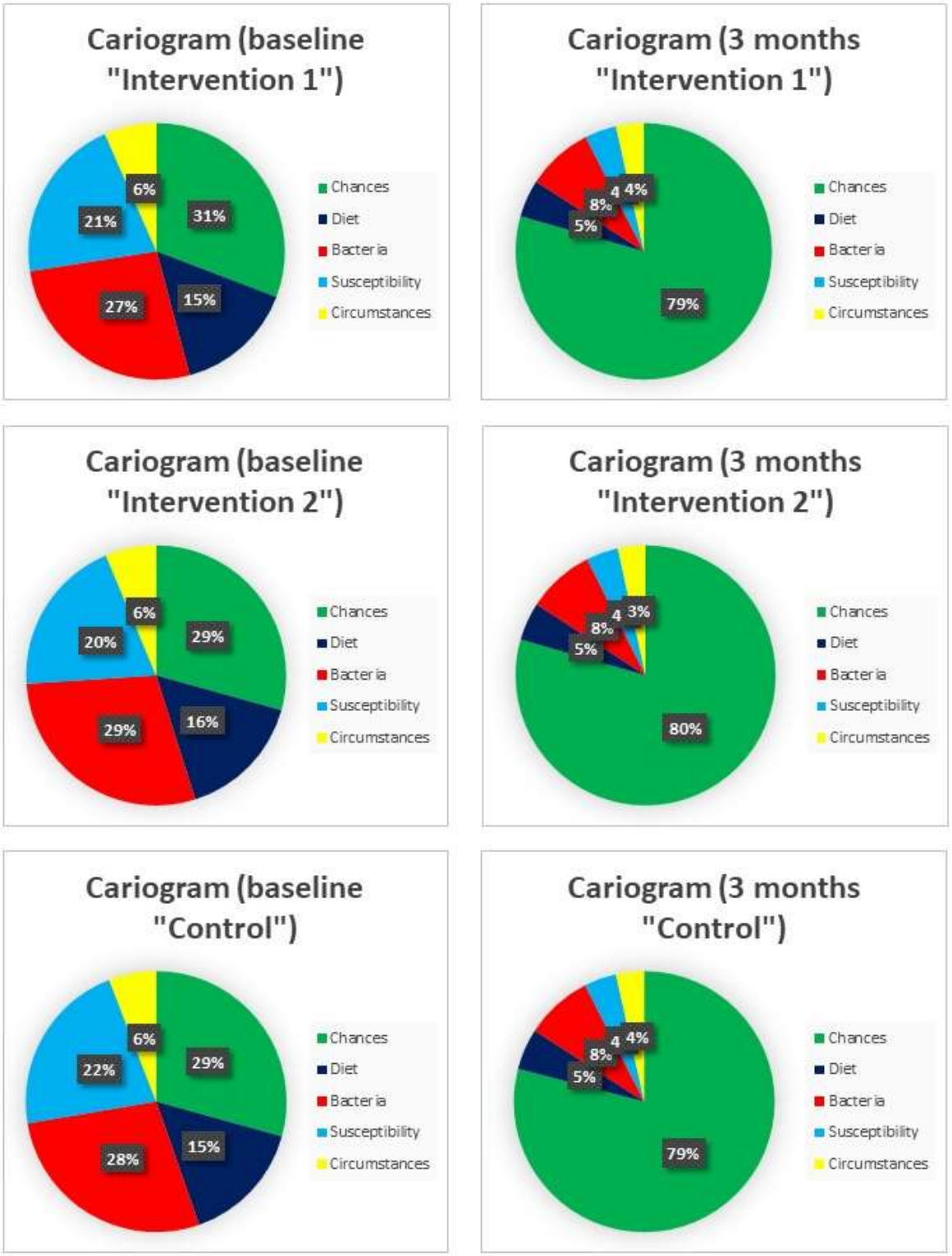
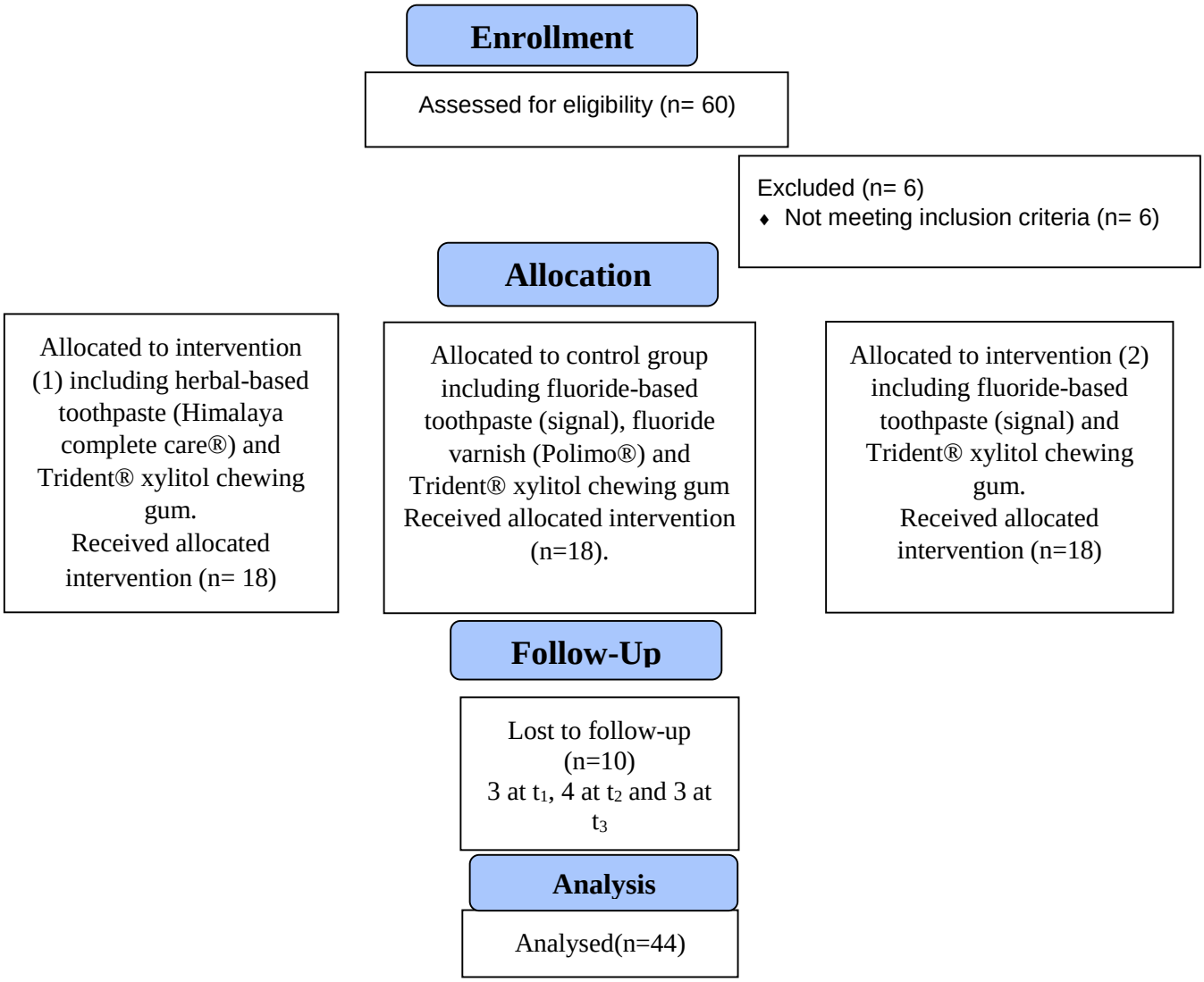


Figure (1) Intragroup comparison between different follow-up periods



4.Discussion

The present study was directed to evaluate the caries preventive effect of different preventive regimens using herbal or fluoride toothpastes compared to using fluoride varnish and fluoride toothpaste only on caries risk assessment of high caries risk patients. In addition to sugar free gum containing xylitol which was also found in the Polimo® fluoride varnish that was used at baseline visit for one of the groups.

It was demonstrated that Miswak (one of the components of Himalaya toothpaste) has exceptional antibacterial properties against Streptococcus Mutant. Miswak was found to have a substantial influence on the growth of Streptococcus and staphylococcus aureus where it holds approximately 1.02 µg/g of total fluoride [8]. It is made from the extraction of the Miswak plant purely “Salvadora persica”.

Miswak's astringent and antibacterial characteristics aid in tooth decay prevention, plaque removal, and gum disease prevention. Furthermore, these products are free of abrasive agents [9]**.** Moreover, it is equal in antibacterial efficacy as chlorhexidine gluconate [10]. It has the capability to halt the progress of the cariogenic bacteria owing to its components like fluoride, thiocyanate agent, sodium chloride, potassium chloride, saponin, and tannins [10]. Another component is Neem (Azadirachta indica) which is an effective antibacterial agent against both Streptococcus species and Lactobacillus species [11]. Its antimicrobial efficacy is through the active compounds which are nimbidin, azadirachtin, and nimbinin [12]. Neem's antibacterial effects

have been confirmed by modern research such as patil et al. [13] Pomegranate is known also to possess bactericidal, antioxidant, and anti-inflammatory traits [14]. Babool (Acacia nilotica) has an antibacterial efficacy against both S. mutans and L. acidophilus due to the phytochemical components which include alkaloids, saponins, cardiac glycosides, tannins, flavonoids, and finally anthraquinones [15].

Fluoride (F) is most commonly found in fluoridated dentifrices as "sodium fluoride or sodium monofluorophosphate". Fluoride inhibits the cellular enzymes through the direct binding of fluoride or hydrogen fluoride, or in conjunction with metals or increases proton permeability in cell membranes (as hydrogen fluoride) (acting as a transmembrane proton carrier). Fluoride present inside the cell hinders glycolytic enzymes, leading to reduction in the generation of glycolysis acid. It also decreases cytoplasmic pH, altering mutans streptococci's acid production and acid tolerance [9]. The evidence supporting fluoride toothpastes, gels, and varnishes' effectiveness in preventing caries is apparent and has been proved conclusively in multiple Cochrane systematic studies [16]. Effective dietary counseling, plaque control improvement, and increased fluoride implementation, such as using 1,450 PPM fluoridated toothpaste, can decrease the chance of incidence of dental caries as it was also found in our study [16].

Polimo® fluoride varnish showed the greatest antibacterial effect with the highest diameter of the inhibition zone and the max area of no growth according to Jafari et al. [17]. Topical fluoride reacts with saliva to generate calcium fluoride (CaF2) compounds on the surface of the teeth as a result, it works as a long-term supply of fluoride following application. Furthermore, fluoride can limit the quantity of S. mutans and inhibit acid formation by bacteria. [17], which is consistent with our study. Fluoride varnishes should be administered four times a year to persons with a high caries risk and once every six months to those with a low caries risk [3].

The fluoride varnish used in this study (Polimo®) and the chewing gum both had xylitol in their components which is a five-carbon natural sugar alcohol that is not fermentable by most oral bacteria. Xylitol has been demonstrated in several studies to decrease dental plaque as well as the amount of S. mutans (in vivo and in vitro). The antimicrobial properties of xylitol chewing gum have been investigated in clinical settings. It was discovered that after chewing gums were consumed, S. mutans levels in saliva decreased considerably [18]. Chewing gum with non-cariogenic sweeteners after meals as conducted in this study causes a rise in pH as a result of higher bicarbonate levels and accelerated salivary flow. [19].

The findings of studies conducted by Karabekiroğlu and Ünlü [3] and Achilleos et al. [20] confirmed the results of the current research, indicating that using a preventive regimen containing 1450 ppm fluoride-based toothpaste and fluoride varnish would reduce participants caries risk. Naumova et al. [21] found that using fluoride-based toothpaste reduced oral bacteria while also improved microbial reduction in all biofilms when brushing for longer periods of time.According to Karabekiroğlu and Ünlü [3], many researchers found that a three-months' time period is enough to identify preventative strategies. Other research, on the other hand, suggests that a time of at least six months is best for detecting any negative or positive effects of caries prevention measures.

Cariogram was validated by many studies such as those by Peker et al., Madhu Mitha et al., Hayes et al. [22,23,24] for caries risk assessment. The Cariogram application is a contemporary tool for measuring caries risk. It can predict an individual's caries risk profile and show it visually to patients and detect risk variables in order to establish the best treatment strategy where it was proven to be highly useful in clinical practice for evaluating caries risk and non-invasive caries therapy [25]. In our investigation, the values for the cariogram sections have fallen noticeably in all groups after three months period when compared to the baseline. There were no significant differences between preventative measures in terms of chance of avoiding caries. Hence, the proposed hypothesis was accepted as all three preventive regimens could enhance patients' caries risk regarding the chance of avoiding caries. The findings of this clinical study emphasize the important role played by the caries preventive regimen with different toothpastes

Himalaya toothpaste can possess antibacterial action and this was confirmed by Bhattacharjee et al [26] that found that herbal toothpaste like Dabur red, Babool and Himalaya were efficient, and presented significant results against isolated bacteria with antibacterial characteristics which was also confirmed by Prabhuswamy et al., Vyas et al. and Biria et al. [14,27,28]. It was shown by Arjun et al [4] that Himalaya Herbal toothpaste® has a better inhibitory role of the caries development than fluoride-based toothpaste. It was also found that brushing with miswak and fluoridated toothpaste significantly decreased plaque scores amongst school children [29]. Moreover, Salvadora persica affected the salivary bacterial count in favor of species with fewer risk of caries incidence. This in addition to the antibacterial, anticariogenic, and antiplaque properties [30, 31] of the herbal toothpastes, it was found that they are safer than that of fluoride toothpastes [27] and could be more effective alternative, providing an ideal anticariogenic home care regimen.

Limitation of the study:

This study assessed preventative measures treatment, which is crucial for community health, but it has certain limitations. Firstly, the short time frame of the follow-up. The nature of the study was mostly based on patient compliance, which may have led to differences in adherence to the preventative regimen guidelines and hence, this dictated more effort in order to manage this limitation.

5.Conclusion

In high caries risk patients, caries preventive regimens based on herbal toothpaste have similar clinical performance to those based on fluoride toothpaste and varnish along three months' follow-up period.

Clinical significance: In high-caries-risk individuals, preventive regimens comprising various toothpastes have a favorable impact on caries prevention

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper. No funding was received for conducting this study.

Ethical approval:

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments.

Informed consent:

Informed consent was obtained from all individual participants included in the study.

References

1.Kooshki, F., Tabatabaei, F.S., Tajik, S. and Aayan, A., 2018. The comparison of antimicrobial effects of herbal and chemical agents on toothpaste: An experimental study. Dental research journal, 2018,15(4),289.

2.Suneja, E.S., Suneja, B., Tandon, B. and Philip, N.I., 2017. An overview of caries risk assessment: Rationale, risk indicators, risk assessment methods, and risk-based caries management protocols. Indian Journal of Dental Sciences,2017, 9(3), p.210.

3.Karabekiroğlu, S. and Ünlü, N., 2017. Effectiveness of different preventive programs in cariogram parameters of young adults at high caries risk. International journal of dentistry, 2017,1–10.

4.Arjun, T.N., Gouraha, A., Maheshwari, A. and Chavan, K., 2015. Efficacy of herbal dentifrice in the reduction of dental caries compared against commercially available fluoride containing dentifrice: an experimental trial. WORLD JOURNAL OF PHARMACY AND PHARMACEUTICAL SCIENCES,2015,4, (04),800-807.

5.Mitrakul, K., Srisatjaluk, R., Vongsawan, K., Teerawongpairoj, C., Choongphong, N., Panich, T. and Kaewvimonrat, P., 2017. Effects of short-term use of xylitol chewing gum and moltitol oral spray on salivary Streptococcus mutans and oral plaque. The Southeast Asian journal of tropical medicine and public health, 2017,48(2), pp.485-93.

6.AbdAllah, E.A., Metwalli, N.E. and Badran, A.S., 2018. Effectiveness of a one-year oral health educational and preventive program in improving oral health knowledge and oral hygiene practices of a group of Autistic Egyptian children and their caregivers. Future Dental Journal, 2018,4(1), pp.23-29.

7.Gomar-Vercher, S., Simón-Soro, A., Montiel-Company, J. M., Almerich-Silla, J. M., & Mira, A. (2018): Stimulated and unstimulated saliva samples have significantly different bacterial profiles. Plos One, 13(6): 1–

12.
8.Ezoddini-Ardakani, F., 2010. Efficacy of Miswak (salvadora persica) in preventing dental caries. Health, 2010, 2(05), p.499.
9.Bhati, N., Jaidka, S. and Somani, R., 2015. Evaluation of antimicrobial efficacy of Aloe vera and Meswak containing dentifrices with fluoridated dentifrice: An in vivo study. Journal of International Society of Preventive & Community Dentistry,2015, 5(5), p.394.
10.Niazi, F., Naseem, M., Khurshid, Z., Zafar, M.S. and Almas, K., 2016. Role of Salvadora persica chewing stick (miswak): A natural toothbrush for holistic oral health. European journal of dentistry, 2016, 10(2), 301.
11.Premlal, K.R., 2016. Effect of Azadirachta indica Stem Bark Extract on Carious Lesions in Deciduous Teeth. Scholars Journal of Dental Sciences, 2016,3(10),284-286.
12.Pachava, S., Chandu, V.C., Yaddanapalli, S.C., Dasari, A.B. and Assaf, H.M., 2019. Comparing caries experience between Azadirachta indica chewing stick users and toothbrush users among 35-44-year-old rural population of Southern India. Journal of International Society of Preventive & Community Dentistry,2019, 9(4),417.
13.Patil, S., Venkataraghavan, K., Anantharaj, A. and Patil, S., 2010. Comparison of two commercially available toothpastes on the salivary streptococcusmutans count in urban preschool children -an in vivo study. Indernational Dentisrty - SA.2010, 4(12): pp72-81.
14.Vyas, S. and Kulkarni, S., 2018. Patanjali Dant Kanti: Is it worth all the hype!? Comparative evaluation with other herbal dentifrices for efficacy against S. mutans. International Journal of Applied Research,2018, 4(2),212-215.
15.Shekar, B.C., Nagarajappa, R., Jain, R., Singh, R., Thakur, R. and Shekar, S., 2016. Antimicrobial efficacy of Acacia nilotica, Murraya koenigii (L.) Sprengel, Eucalyptus hybrid, Psidium guajava extracts and their combination on Streptococcus mutans and Lactobacillus acidophilus. Dental research journal, 2016, 13(2), 168.
16.Pitts, N.B., Zero, D.T., Marsh, P.D., Ekstrand, K., Weintraub, J.A., Ramos-Gomez, F., Tagami, J., Twetman, S., Tsakos, G. and Ismail, A., 2017. Dental caries. Nature reviews Disease primers, 3(1), pp.1-16.
17.Jafari, K., Hekmatfar, S. and Fereydunzadeh, M., 2018. In vitro comparison of antimicrobial activity of conventional fluoride varnishes containing xylitol and casein phosphopeptide-amorphous calcium phosphate. *Journal of International Society of Preventive & Community Dentistry*, 2018, *8*(4), p.309.
18.Emamieh, S., Khaterizadeh, Y., Goudarzi, H., Ghasemi, A., Baghban, A.A. and Torabzadeh, H., 2015. The effect of two types chewing gum containing casein phosphopeptide-amorphous calcium phosphate and xylitol on salivary Streptococcus mutans. Journal of conservative dentistry: JCD, 2015, 18(3), p.192.
19.Padminee, K., Poorni, S., Rashmi, D.D. and Srinivasan, M.R., 2018, Effectiveness of casein phosphopeptide-amorphous calcium phosphate and xylitol chewing gums on salivary pH, buffer capacity, and Streptococcus mutans levels: An interventional study.International Journal of Oral Health Dentistry 2018, 3(3):163-168
20.Achilleos, E., Rahiotis, C., Kavvadia, K. and Vougiouklakis, G., 2019. Clinical Evaluation of Two Different Prevention Programs in Adults Depending on Their Caries Risk Profile: One-year Results. Operative dentistry,2019, 44(2),127-137.
21.Naumova, E.A., Weber, L., Pankratz, V., Czenskowski, V. and Arnold, W.H., 2019. Bacterial viability in oral biofilm after tooth brushing with amine fluoride or sodium fluoride. Archives of oral biology, 2019,97,91-96.
22.Peker, I., Mangal, T., Erten, H., Alp, G., Avci, E. and Akca, G., 2012. Evaluation of caries risk in a young adult population using a computer-based risk assessment model (Cariogram). Journal of Dental Sciences, 2012, 7(2), pp.99-104.
23.Mitha, M.M., Nijesh, J.E., Chaly, P.E., Priyadharshini, I., Junaid, M. and Vaishnavi, S., 2016. Caries risk assessment among 12–13 year old school-going children of government and private schools of Tirupur district, Tamil Nadu. Journal of Indian Society of Pedodontics and Preventive Dentistry, 34(3),244.
24.Hayes, M., Da Mata, C., McKenna, G., Burke, F.M. and Allen, P.F., 2017. Evaluation of the Cariogram for root caries prediction. Journal of dentistry, 2017,62, pp.25-30.
25.Doitchinova, L., Kirov, D., Nikolova, J. and Topalova-Pirinska, S., 2020. Caries risk

assessment in adults using the Cariogram. Folia Medica, 2020, 62(4), pp.831-837.

26.Bhattacharjee, S., Nath, S., Bhattacharjee, P., Chouhan, M. and Deb, B., 2018. Efficacy of Toothpastes on Bacteria Isolated from Oral Cavity. International Journal of Medicine and Public Health,2018,8,2,89-92.

27.Prabhuswamy, B., Mallikarjun, N., Nagaraj, K. and Simpi, B., 2018. Comparative evaluation of anticariogenic activity of commercially available herbal dentifrices. SRM Journal of Research in Dental Sciences, 2018, 9(2),58.

28.Biria, M., Rezvani, Y., Yadegari, Z., Rahmati, M.H. and Iranparvar, P., 2021. Antimicrobial Efficacy of Herbex and Himalaya Herbal Toothpastes: An In Vitro Experimental Study. Dental Hypotheses,2021, 12(3), p.118.

29.Sabbagh, H.J., AlGhamdi, K.S., Mujalled, H.T. and Bagher, S.M., 2020. The effect of brushing with Salvadora persica (miswak) sticks on salivary Streptococcus mutans and plaque levels in children: a clinical trial. BMC complementary medicine and therapies, 20(1), pp.1-6.

30.Nordin, A., Saim, A.B., Ramli, R., Hamid, A.A., Nasri, N.W.M. and Idrus, R.B.H., 2020. Miswak and oral health: An evidence-based review. Saudi journal of biological sciences, 27(7), pp.1801-1810.

31.Al-Dabbagh, S.A., Qasim, H.J. and Al-Derzi, N.A., 2016. Efficacy of Miswak toothpaste and mouthwash on cariogenic bacteria. Saudi medical journal, 37(9), p.1009.