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Effectiveness of Apple Cider Vinegar and Mechanical Removal on Dental Plaque and Gingival inflammation in Preschool Children (in-vivo Study)

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Abstract:

Background: Daily oral care is a great challenge for preschool children. Therefore, it is essential to study methods that facilitate oral care to establish early oral hygiene and improve oral health in these groups.
This study was designed evaluate the effectiveness of apple cider vinegar (ACV) 5% and mechanical plaque removal with a manual toothbrush without toothpaste or both ACV with mechanical removal, on dental plaque and gingivitis in preschool children.
Materials and Methods: The sample consisted of 75 children aged 3-6 years, divided into three groups based on the applied method. The modified plaque index (TQHPI) and the modified gingival index (MGI) were used to assess the effectiveness of each studied method. Data were collected once before the intervention and then monthly for three months following the intervention.
Results: This study showed decreasing in (TQHP) in all groups as between T0 and T3. The greatest reduction in TQHP occurred in the mechanical brushing with ACV group, followed by the ACV group, with no statistically significant differences($p>0.05$), then the mechanical brushing group, which showed a statistically significant difference when compared to both ACV group and the mechanical brushing with ACV group individually. The greatest decreasing in (MGI) was found in ACVgroup and the mechanical brushing with ACV group, with no statistically significant differences at all times compared to the mechanical brushing group, where a statistically significant difference was found between the mechanical brushing group and ACV group after two months and three months.
Conclusions: Apple cider vinegar, whether alone or combined with manual brushing, showed a greater and faster effect on dental plaque and gingivitis compared to mechanical brushing without toothpaste.
Keywords: Apple Cider Vinegar, Dental Plaque, Mechanical Removal, Preschool Children.

مقارنة بين تأثير خل التفاح والازالة الميكانيكية على اللويحة السنية والالتهاب اللثوي عند الأطفال تحت سن المدرسة (دراسة سريرية)

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الملخص:

المقدمة: تشكل العناية الفموية اليومية تحديا كبيرا عند الأطفال تحت سن المدرسة. ولذلك كان من الأهمية دراسة طرق تسهل العناية الفموية لتأسيس عناية فموية مبكرة وتحسين الصحة الفموية لدى هذه الفئات.

الهدف: تقييم فعالية كل من خل التفاح 5% والتفريش الميكانيكي بفرشاة يدوية دون استخدام المعجون او كلاهما معا في اللويحة السنية والالتهاب اللثوي عند أطفال سليمين تحت سن المدرسة.

المواد والطرائق: تألفت العينة من 75 طفل بأعمار 3–6 سنوات قسمت الى ثلاث مجموعات حسب الطريقة المطبقة. استخدم مشعر اللويحة المعدل (TQHPI) ومشعر اللثة المعدل (MGI) لتقييم فعالية كل من الطرائق المدروسة، وجمعت البيانات مرة قبل التداخل ثم مرة كل شهر بعد التداخل ولمدة ثلاثة أشهر.

النتائج: أظهرت نتائج الدراسة الحالية تناقص في قيم مشعر اللويحة السنية المعدّل TQHP المعدّل TQHP في مجموعة التفريش الميكانيكي مع خل التفاح ثم في مجموعة خل التفاح دون وجود فروق دالة احصائيا بين المجموعتين ثم مجموعة التفريش الميكانيكي وبوجود فارق دال احصائيا عند مقارنتها مع مجموعة خل التفاح ومجموعة التفريش الميكانيكي مع خل التفاح كل على حدة.

وجد أكبر تناقص في قيم مشعر اللثّة المعدّل MGI في مجموعة خل التفاح ومجموعة التفريش الميكانيكي مع خل التفاح دون وجود فروق دالة احصائيا بينهما في كل الفترات الزمنية المدروسة وذلك مقارنة بمجموعة التفريش الميكانيكي. حيث وجد فرق دال احصائيا بين مجموعة التفريش الميكانيكي ومجموعة خل التفاح وذلك بعد شهرين وبعد ثلاثة أشهر.

الاستنتاجات: أظهرت المجموعات الحاوية على خل التفاح سواء بمفرده او مع التفريش الميكانيكي تأثيرا أكبر وأسرع على اللويحة السنية والالتهاب اللثوي مقارنة بالتفريش الميكانيكي دون معجون.

الكلمات المفتاحية: خل التفاح، اللويحة السنية، الازالة الميكانيكية، الأطفال تحت سن المدرسة.

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Introduction:

Daily oral care is considered a great challenge for young children due to the difficulty or impossibility of performing oral hygiene procedures independently, which requires caregivers assist (Zhou, Wong, McGrath, 2020). These challenges have been associated with children difficult child behaviors, stress, family planning problems, and routine (de Jong-Lenters, L'Hoir, Polak, Duijster, 2019).

The accumulation of dental plaque on tooth surfaces and gingiva is the reason of dental caries and generalized chronic gingivitis. Therefore, controlling dental plaque through repeated removal or prevention of its formation is an essential part—and perhaps the most important aspect—of controlling these diseases. Additionally, moderate sugar consumption and the use of fluoride are recommended (Chapple et al., 2015).

Many studies have found that mechanical control measures without any adjunctive agents were effective in reducing dental plaque and gingivitis (Figuero et al., 2017; van der Sluijs et al., 2018; Paraskevas et al., 2006). However, due to the difficulty in accessing interproximal areas and gingival areas of tooth using a toothbrush alone, especially at younger ages (de Jong-Lenters et al., 2019), chemical agents such as fluoride-containing toothpaste and mouth rinses like chlorhexidine have been used as adjuncts to mechanical control measures to reduce dental caries and periodontal diseases but that is not substitute for tooth brushing (Figuero et al., 2017).

Apple cider vinegar is fermented apple juice, primarily composed of acetic acid, with a typical concentration of acetic acid ranging from 4% to 8% by total volume. Vinegar derives many of its other compounds in the form of enzymes, fibers, minerals, and vitamins from its source material. Apple cider vinegar contains vitamins B1, B2, B6; biotin; folic acid; niacin; pantothenic acid; and vitamin C, along with small amounts of minerals such as sodium (3 mg/ml), phosphorus, potassium (125 mg/ml), calcium (1.5 mg/100 ml), iron (0.02 mg/100 ml), and magnesium (2.45 mg/100 ml) (Kalemba-Drozdz et al., 2020). Apple cider vinegar has antibacterial properties due to acetic acid; studies have shown that acetic acid inhibits Shigella proliferation by interfering with glucose metabolism and affects the growth of both Gram-positive and Gram-negative bacteria, including Streptococcus mutans and Candida albicans (Huang et al., 2011).

In another study, it was found that the minimum concentration required to inhibit Candida albicans was pure undiluted apple cider vinegar (5% acid), while for Staphylococcus aureus, it was diluted to ½ (2.5% acid), and for Escherichia coli, growth was significantly inhibited at a concentration of less than 1/50 (equivalent to 0.1% acid) (Yagnik, Serafin, A, 2018). Additionally, vinegar (4% acetic acid) was compared with glycerin and distilled water, where 4% acetic acid showed the maximum plaque-reducing effect of 25%, followed by glycerin and distilled water, respectively. This adds to the antibacterial effect of vinegar, providing a strong synergistic effect in controlling plaque (P. K. Bhat MA, Trivedi D, Acharya AB., 2014).

Materials and Methods:

Study Design: A randomised clinical trial to evaluate the effectiveness of three methods in dental plaque and gingivitis control in healthy children. Data were collected once before the intervention then once a month for three months.

Ethical Approval:. Approval was obtained from the Scientific Research Committee at the Faculty of Dentistry, University of Damascus (405 P/M dated 26/12/2019), , consent was obtained from the Ministry of Education, followed by approval from Early Childhood Developement Regional Center.

Sample size : seventy five healthy cooperative children aged 3-6 years from both genders, who do not suffer from any general systemic diseases and were not taking any medication continuously. Each child had a responsible person supervising the brushing and ACV applying process. Children have primary dentition only without any permanent teeth. They do not take any antibiotics for two weeks prior to the examination and did not have dental abscesses or acute viral infections. They were studied at Early Childhood Developement Regional Center in Mezzeh.

The sample was divided into three subgroups, each consisting of 25 children:

Group One: apple cider vinegar 5% was applied on teeth using cotton once daily for three months.

Group Two: mechanical brushing without toothpaste once daily for three months.

Group Three: mechanical brushing without toothpaste and then 5% apple cider vinegar was applied on teeth once daily for three months.

Intervention:

The first examination of the children was done in the presence of the caregiver of each child and then every participant was given according to its group, either apple cider vinegar or a toothbrush. This is to explain and teach caregivers how to apply method.

Evaluation and follow-up:

Plaque accumulation and gingival status were evaluated using Turesky of the Quigley–Hein plaque index (TQHPI) (Table 1) and modified gingival index (MGI) (Table 2)on buccal surfaces of 55, 61, 64, 75, 81, and 84, according to Ramfjord at seven times (pre-intervention baseline (T0), post-intervention at 1 month (T1), 2 months (T2), 3 months (T3), 4 months (T4), 5 months (T5), 6 months (T6).

Statistical Analysis:

Statistical Analysis was performed using the SPSS program version (SPSS Inc., Chicago, IL, USA). Indices value Continuous valuables were presented as mean difference and standard erorr. Intragroup comparisons, (TQHPI), and MGI scores, were analyzed by one-way ANOVA test and Bonferroni test for paired comparisons and inter-observed times were analyzed by Paired t-test. A significance level of 0.05 was adopted.

Results:

the intragroups comparisons showed that the greatest decrease in (TQHPI) scores was observed in the mechanical brushing with ACV group, followed by the ACV group, with no significant difference ($p>0.05$) in time (T1 to T3). The mechanical brushing group showed a significant difference when compared to both ACV group and the mechanical brushing with ACV group **Table (3)**.
all studied groups showed an improvement in plaque accumulation scores in time (T0 to T3) with a significant difference ($p < 0.05$) **Table(5)**

Table (4) shows that the greatest decrease in (MGI) scores was found in the ACV group and the mechanical brushing with ACV group, with no significant difference ($P<0.05$) in time (T0 to T3) followed by mechanical brushing group which showed a significant difference when compared to ACV group in time (T2-T3)
Means and standard deviations of MGI scores are described in (**Table 6)** showed an improvment in gingival status with a significant difference ($p<0.05$) in all paired comparisons between (T0 to T3) and in all studied groups
also intragroups comparisons showed no significant difference between the studied groups in time (T2)

Discussion:

Daily oral care is a great challenge for young children, which is difficult to perform oral hygiene procedures either alone or with parents (Zhou et al., 2020). Therefore, efforts have been directed towards studying methods that may facilitate oral hygiene procedures for caregivers , to establish early good oral health and reduce the burden of future treatments when needed (Brookes, Bescos, Belfield, Ali, Roberts, 2020).
Plaque removal is related to controlling associated diseases such as dental caries and gingivitis, through mechanical procedures and chemical adjuncts (Chapple et al., 2015). The results of the current study showed the greatest decrease in both (TQHPI) and (MGI) scores in the groups which containing ACV, whether used alone or in combination with mechanical brushing, compared to mechanical brushing without any adjunctive agent. This can be attributed to apple cider vinegar (acetic acid), which has a plaque-dissolving effect (P. K. Bhat MA, Trivedi D, Acharya AB., 2014), playing a role in reducing dental plaque accumulation and gingival inflammation (Salman Younis), also in inhibiting the maturation process of dental plaque (Liu Hannig, 2020). Additionally, apple cider vinegar has antibacterial and anti-inflammatory properties (HERRERA SANDOVAL, 2012; Huang et al., 2011).
In contrast, mechanical brushing alone had an effect on the gingivitis related to plaque removal without any additional anti-inflammatory chemical effect.

Conclusions:

Groups containing apple cider vinegar showed a greater and faster effect on dental plaque and gingivitis compared to the mechanical brushing group without toothpaste.

Table(1): A grading system for plaque accumulation

Score	Criteria
0	No plaque present
1	Separate flecks of plaque at the cervical margin
2	A thin continuous back of plaque (up to 1 mm) at the cervical margin
3	A band of plaque wider than 1 mm but covering less than one-third of the side of the crown of the tooth
4	Plaque covering at least one-third but less than two-thirds of the side of the crown of the tooth
5	Plaque covering two-thirds or more of the side of the crown of the tooth

Table(2): The grading system of gum status for the (MGI)

Score	Criteria
0	Absence of inflammation
1	Mild inflammation or with slight changes in color and texture but not in all portions of gingival marginal or papillary
2	Mild inflammation, such as the preceding criteria, in all portions of gingival marginal or papillary
3	Moderate, bright surface inflammation, erythema, edema, and/or hypertrophy of gingival marginal or papillary
4	Severe inflammation: erythema, edema, and/or marginal gingival hypertrophy of the unit or spontaneous bleeding, papillary, congestion, or ulceration

Table(3): Mean difference and standard erorr for score of plaque accumulation for the (TQHPI) at the follow-up times T1: 1 month; T2: 2 months; T3: 3 months; for groups G1: ACV; G2: mechanical brushing G3: ACV with mechanical brushing; a: Bonferroni test

Time points	GroupA	GroupB	Mean difference	Standard erorr	p<0.05[a]
T1	G1	G2	− 0.49	0.15	G1<G2
		G3	0.04	0.15	−−−−−−−
	G2	G3	0.53	0.15	G2>G3
T2	G1	G2	− 0.28	0.11	G1<G2
		G3	0.15	0.11	−−−−−−−
	G2	G3	0.43	0.11	G2>G3
T3	G1	G2	− 0.01	0.09	−−−−−−−
		G3	0.27	0.09	G1>G3
	G2	G3	0.28	0.09	G2>G3

Table (4): Mean difference and standard erorr for score of plaque accumulation for the (MGI) at the follow-up times T1: 1 month; T2: 2 months; T3: 3 months; for groups G1: ACV; G2: mechanical brushing G3: ACV with mechanical brushing; a: Bonferroni test

Time points	Group A	Group B	Mean difference	Standard erorr	P<0.05[a]
T0	G1	G2	− 0.40	0.16	G1<G2
		G3	− 0.02	0.16	------
	G2	G3	0.38	0.16	------
T2	G1	G2	− 0.32	0.10	G1<G2
		G3	0.10	0.10	-----
	G2	G3	0.43	0.10	G2>G3
T3	G1	G2	− 0.18	0.06	G1<G2
		G3	− 0.08	0.06	-----
	G2	G3	0.10	0.06	-----

Table(5): Mean and standard deviations for each score of plaque accumulation for the (TQHPI) at the different periods for G1: ACV; G2: mechanical brushing;G3: ACV with mechanical brushing; a: one-way ANOVA test; b: Paired t-test

Groups	G1	G2	G3	p<0.05[a]
T0	1.93 ±0.58	2.03±0.54	1.84±0.53	-----
T1	0.97±0.52	1.46±0.55	0.93±0.48	0.001
T2	0.75±0.35	1.03± 0.45	0.60±0.35	0.001
T3	0.62±0.38	0.63±0.34	0.36±0.16	0.003
p<0.05[b]	T0>T1 T1>T2 T2>T3	T0>T1 T1>T2 T2>T3	T0>T1 T1>T2 T2>T3	

Table(6): Mean and standard deviations for each score of (MGI) at the different periods for G1: ACV; G2: mechanical brushing;G3: ACV with mechanical brushing; a: one-way ANOVA test; b: Paired t-test

Groups	G1	G2	G3	p<0.05[a]
T0	1.43 ±0.49	1.83±0.56	1.45±0.60	0.020
T1	0.87±0.40	1.12±0.48	0.92±0.51	0.127
T2	0.62±0.27	0.94± 0.45	0.52±0.32	------
T3	0.42±0.22	0.60±0.16	0.50±0.28	0.023
p<0.05[b]	T0>T1 T1>T2 T2>T3	T0>T1 T1>T2 T2>T3	T0>T1 T1>T2 T2>T3	

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