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ESTHETIC MANAGEMENT OF ANTERIOR TEETH UTILIZING TWO MICRO ABRASION TREATMENTS: RANDOMIZED CLINICAL TRIAL

Shadwa Hatem Kabil* *and* Sarah M.S. Khalil**

ABSTRACT

Introduction: Hypomineralized, discolored enamel is a common defect affecting permanent teeth of children and young adults, microabrasion is one of the commonly used conservative treatments to such a defect. Objective: To compare the efficacy of enamel microabrasion using Opalsture (6.6%HCL) and Antivet (21%HF). Materials and methods: 24 participants free from any systemic disease aged from 9years to 18years old were included in the study those participants were suffering from stained hypomineralized teeth having the following inclusion criteria: Teeth with Degree 1(mild) hypomineralization according to the Wetzel and Reckel scale, were consent for treatment and caries-free teeth. Before treatment base line data were recorded regarding teeth sensitivity through 10points verbal rating scale and visual analog scale(VAS) and documentation was made by photographs. Participants were randomly allocated either to the Opalustre group where patients in this group were treated using (Opalustre, Ultradent Products, USA), or the Antivet group where patients in this group were treated using (Antivet- Dental Continental, México). Teeth sensitivity then was assessed immediately after procedure, 1month and 3months and documentation was made by photographs, the patient satisfaction was assessed by 5points lickert scale. Results: Teeth sensitivity was significantly the highest post-operative immediately as it was(1.67 ± 1.72) and (0.42 ± 0.67) regarding Opalustre and Antivet respectively. Opalustre group (1.67 ± 1.72) was significantly higher than Antivet (0.42 ± 0.67) immediately postoperative. Comparing patient satisfaction in both groups, Opalustre group (2.42 ± 0.67) was significantly lower using Lickert scale than the Antivet group. Conclusion: According to the results of current study, Antivet is a promising product in management of discolored enamel.

KEYWORDS: Opalusture, Antivet, Microabrasion, Enamel Discoloration, hypomineralisation

* Assistant Professor, Restorative Dentistry Department, Faculty of Dentistry, The British University in Egypt, Cairo, Egypt
** Assistant Professor, Department of Pediatric Dentistry and Dental Public Health, Faculty of Dentistry, Beni-Suef University

INTRODUCTION

Dental Enamel is formed of tightly packed and highly arranged hydroxyapatite crystals that represent 87% of its total volume and 95% of its total weight while the remaining amount: is water and organic matrix.[1] .

Ameloblasts are well-differentiated specialized cells known to produce Dental Enamel.[1] , Enamel production can be divided into primary phases which involve the production of the protein matrix and delayed phases of mineralization and maturation [1].

Developmental enamel defects are frequently seen in everyday practice, both in primary and permanent dentition.[1] Genetic and/or environmental determinants that influence teeth development are commonly the main cause of both hypomineralisation and hypoplasia [1,2]. Where hypoplasia occurs due to disturbance during the secretion phase and hypomineralization occurs during the mineralization maturation phase [1].

Enamel imperfections in children, adolescents, and adults should not be underemphasized, as dental appearance usually affects how people perceive each other making negative psychosocial judgments [3].

Many Treatment modalities for enamel defects specifically hypomineralization and stained enamel have been discussed in literature including resin infiltration, bleaching, microabrasion, aesthetic restorations, and even veneers [4].

In the case of hypomineralized stained enamel usually, conservative treatment like microabrasion is preferred especially at young age [4].

Croll and Cavanaugh [4] first introduced the microabrasion technique, they suggested the use of 18% hydrochloric acid (HCL)with abrasives to remove brownish enamel discolorations [5]. Lately, this was evolved into a simple, more conservative approach termed 'enamel microabrasion'. It eliminates superficial and intrinsic enamel defects with minimal tissue removal, a prismless, dense layer is formed of the enamel which helps to reflect and refract light so that the little color imperfections in the underlying enamel can be concealed [6].

Recently new tooth enamel cleanser and micro abrasion materials has been introduced to the market "Antivet" containing 21% hydrofluoric acid. the objective of the current study is to assess the Antivet compared to the Opalusture containing 6.6% hydrochloric acid which is commonly used in micro abrasion. The Manufacture claimed that Enamel wear is significantly less when compared to the alternative enamel abrasion methods because its a chemical reaction that occurs during the procedure[7].

MATERIALS & METHODS:

Trial Approval and Registration:

The Ethical Committee of the Faculty of Dentistry – Beni-Suef University, approved the study protocol in respect of the adherence to appropriate research and human subjects' regulations (#REC-FDBSU/06102022-01/SS). This Clinical Trial was registered on November 2022 on the ClinicalTrial.gov website, maintained by the National Library of Medicine (NLM) at the National Institutes of Health (NIH). Its ClinicalTrials.gov identifying number: NCT05900817.

Sample size:

The sample size was twenty-four participants calculated by a statistician. The sample size was calculated depending on a preceding study as a reference [8]. If the mean ± standard deviation of the control group is 2.85 ± 4.5, the estimated difference is 4.5, at least the study needed twelve participants within each group. The sample size was performed by using an independent t- test by using G. power 3.1.9.7.

Participants recruitment:

The two main investigators screened the patients attending the Outpatient clinic of the Department of Pediatric Dentistry and Dental Public Health-

Faculty of Dentistry- Beni-Suef University; who suffered from hypomineralized discolored anterior teeth to participate in this trial. The investigators assessed carefully the medical and dental histories of the patients, performed thorough extra- and intra-oral examinations, and recorded all the data in the diagnostic chart to fulfil the eligibility criteria of the clinical trial which were perceived from previous studies. The inclusion and exclusion criteria are listed in Table (1).

TABLE (1) Eligibility criteria [9]

Inclusion criteria	Exclusion criteria
1- Patients aged from 9-18 years old.	1- Patients with special health care needs or any systemic disease that may delay normal healing.
2- Patients free from any systematic diseases.	2- Patients having bad oral hygiene.
3- Patients agreed to the informed consent*, ascent * and compliant to the follow-up periods.	3- Patients who could not be committed to the follow-up period.
4- Teenagers and young adult patients refrained from tobacco products throughout the current study period.	4- Patients suffering from untreated, periodontal diseases
5- Patients with hypominerlized maxillary and mandibular anterior teeth (incisors and canines) were included.	5- Participants with caries lesions or defective restorations in the anterior teeth.
6- Teeth with Degree 1 (mild) according to the Wetzel and Reckel scale[10]:	6- Sensitive and fractured teeth.
Isolated white and cream to yellowish-brown discolorations on the chewing surface and upper part of the crown and caries-free teeth.	7- Participants who had a history of dental bleaching.
* Written informed consent in Arabic was signed by parents or legal guardians for children who agreed and allowed their children to undergo dental examination and treatment. Young adult patients aged 16-18 years old were able to sign the consent by themselves.	8- Patients participating in other dental studies.
	9- Patients suffering from hypoplasia, amelogenesis imperfecta, dentinogenesis imperfecta, tetracycline stains, fluorosis, or badly broken and missing teeth due to MIH.

Participants' grouping:

All candidates fulfilling the eligibility criteria were randomly allocated using computer-generated randomization (www.random.org) to either control (Opalusture) or intervention (Antivet) groups.

Study setting:

The study was performed in the Outpatient clinic of the Department of Pediatric Dentistry- Faculty of Dentistry - Beni – Suef University.

Allocation:

Twenty-four participants were randomly allocated to either one of the treatments. The concealment mechanism was applied through twenty-four cards that had sequential numbers. One number for each card then each card was placed within an opaque sealed envelope. Then these envelopes were placed in a container (box), and each participant grasped one envelope on the day of treatment.

Blinding:

Participants, outcome assessors, and data analysts were blinded to the treatments during the clinical trial. The outcome assessors were residents of Pediatric Dentistry and Public Health Department- Faculty of Dentistry- Beni-Suef. They were assigned to ask patients and fill outcome

charts immediately, after 1 month, and after 3 months. Both investigators were not involved in assessing the outcome. Two principal Investigators were blinded until the generation of the allocation sequence. Later, two investigators were unblinded within the treatment session due to different treatments packing and steps.

Both Investigators had introduced the treatment protocol to the guardians and patients regarding the main aspects of the trial.

Pre -treatment assessment:

Teeth sensitivity records were recorded through ten points verbal rating scale (0-10) and visual analog scale (VAS) conjugated with emoji faces and documentation were taken by photographs.

Opalustre group:

Patients allocated in this group had their teeth isolated using a rubber dam, then a thin layer (an approximately 1–mm thick) of 6.6% hydrochloric acid paste with silicone carbide fine particles (Opalustre, Ultradent Products Inc, South Jordan, UT, USA) was applied to the affected tooth surface. Using an OpalCups Bristles at a slow RPM (approximately 500 RPM), intermittent medium to heavy pressure was applied for approximately 60 seconds per application to help penetration of the gel into the enamel. The paste was removed with a suction tip then teeth were thoroughly rinsed and, the procedures were repeated as necessary to the case. Figure (1)

Antivet group:

Patients in this group were seated at a 45-degree angle, teeth treated were isolated by rubberdam first then five drops of 21% hydrofluoric acid stabilized by an organic tricarboxylic acid (Antivet- Antivet base, Dental Continental, S.A. de C.V. Industria del Plástico 2113 Fracc. Zapopan Industrial Norte Zapopan Jalisco México) were applied over the tooth's surface using a well-condensed cotton pellet (approximately a 3 mm diameter). When the cotton pellet was pigmented by the stains on the tooth surface, it was changed to a new one. This process took about 1 to 5 minutes per tooth.

Once the tooth surface is free of stains. Using a dry cotton pellet any excess solution was removed from the tooth enamel. Then Antivet alkaline base (It is calcium hydroxide with a pH >12) was applied on the tooth surface using a brush and let it sit for 2 minutes. The neutralizing solution was applied completely up to the gingival margin. Figure (2)

Fig. (1) Method of Opalustre application.

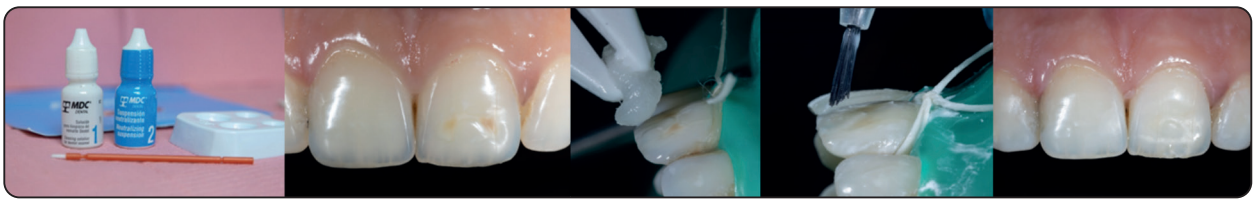

Fig. (2) Method of Antivet application

Post Treatment Assessment:

Teeth sensitivity records were recorded through ten points (0-10) verbal rating scale and visual analogue scale (VAS) conjugated with emoji faces. Patients were assessed immediately after procedure, 1month and 3 months by assessors and documentation were taken by photographs. By 3 month follow up, the patient satisfaction was assessed by five points lickert scale.

Statistical analysis:

Statistical analysis was carried out using SPSS 16 ® (Statistical Package for Scientific Studies), Graph pad Prism & windows Excel and presented in 6 tables and 1 graph.

The study of the given data was conducted using the Shapiro-Wilk test and Kolmogorov-Smirnov test for normality which showed that data age from a normal distribution (parametric data) resembling a normal Bell curve so an Independent t-test was used in the comparison between both groups, while data of VAS and Lickret scale were non-parametric data. Accordingly, a comparison between different time intervals was performed by using the Friedman test, while a comparison between different groups was performed by the using Mann-Whitney test.

RESULTS

The gender distribution of participants in the current study in both groups was presented in Table (2). Comparison between both groups was conducted by using the Chi-square test which showed an insignificant difference between both groups as P>0.05.

TABLE (2) Gender distribution in both groups:

Gender	Opalustre		Antivet		P value
	N	%	N	%	
Male	3	25.0	4	33.3	0.67
Female	9	75.0	8	66.7	0.63

N: count ***%: percentage***

P: probability level which is significant at P ≤ 0.05

Age distribution in both groups was represented in Table (3) showing minimum, maximum, mean, and standard deviation of age in both groups. Comparison between both groups was conducted by using the independent t-test which showed an insignificant differences between them as P >0.05.

TABLE (3) Age of both groups and comparison between them:

	N	Minimum	Maximum	Mean	Standard Deviation	P value
Opalustre	12	9.00	18.00	13.92	3.82	0.32
Antivet	12	12.00	18.00	15.17	2.04	

P: probability level which is significant at P ≤ 0.05

Sensitivity evaluation using visual analog scale (VAS):

Mean and standard deviation of sensitivity in both groups at different time intervals were presented in Table (4).

Effect of time by using Friedman`s test (Comparison between different time intervals)

The sensitivity was significantly the highest post-operative immediately as it was (1.67±1.72) and (0.42 ± 0.67) regarding Opalustre and Antivet respectively.

Effect of material by using Mann Whitney's test (Comparison between both groups):

Opalustre group (1.67±1.72) was significantly higher than Antivet(0.42±0.67) immediately post-operative as P<0.05, while there was no sensitivity in other intervals in both groups.

Association between gender and VAS:

In the Opalustre group, the mean and the (±) standard deviation of sensitivity in males (0.33±0.58) was significantly lower than females (2.11±1.76) immediately postoperative. While in the Antivet group, the mean and the (±) standard deviation of sensitivity in males (0±0) was insignificantly lower than females (0.63±0.74) immediately postoperative, as shown in Table(5).

TABLE (4) Sensitivity evaluation using VAS in both groups at different time intervals and comparison between them:

Visual scale	Opalustre		Antivet		P value (Mann Whitney's test)
	M	SD	M	SD	
Pre-Operative sensitivity	0.00 a	0.00	0.00 a	0.00	------
Post operative immediately	1.67 b	1.72	0.42 b	0.67	0.03*
After 1 month	0.00 a	0.00	0.00 a	0.00	------
After 3 months	0.00 a	0.00	0.00 a	0.00	------
P value (Friedman`s test)	<0.0001*		0.007*		

M: mean SD: standard deviation P: probability level which is significant at P ≤ 0.05
Means with the same superscript letters were insignificantly different as P > 0.0.5
Means with different superscript letters were significantly different as P <0.05.

TABLE (5) Mean and standard deviation of sensitivity using VAS in both males and females regarding both groups:

	Opalustre					Antivet				
	Male		Female		P value	Male		Female		P value
	M	SD	M	SD		M	SD	M	SD	
Pre-Operative sensitivity	0.00	0.00	0.00	0.00	----	0.00	0.00	0.00	0.00	-----
Post operative immediately	0.33	.58	2.11	1.76	0.01*	0.00	0.00	0.63	0.74	0.13
After 1 month	0.00	0.00	0.00	0.00	----	0.00	0.00	0.00	0.00	-----
After 3 months	0.00	0.00	0.00	0.00	-----	0.00	0.00	0.00	0.00	-----

*M: mean SD: standard deviation *Significant difference as P<0.05.*

Correlation between age and VAS

Correlation between age and visual scale was performed by using Pearson's correlation coefficient which showed a negative, moderate insignificant correlation in the Opalustre group, while it revealed a negative, weak insignificant correlation in the Antivet group, as presented in Table (6).

TABLE (6) Correlation between age and sensitivity using VAS in both groups:

	Opalustre		Antivet	
	R	P value	r	P value
Pre-Operative sensitivity	0	0	0	0
Post operative immediately	-0.42	0.17	-0.23	0.45
After 1 month	0	0	0	0
After 3 months	0	0	0	0

R: Pearson's correlation coefficient.

Sensitivity evaluation using verbal scale:

The frequency and percentage of different sensitivity scales in both groups in different intervals were presented in Table (7).

TABLE (7) Sensitivity evaluation using verbal scale in both groups at different intervals.:

		No pain		Mild, annoying pain		Nagging, uncomfortable, troublesome pain		Distressing, miserable pain		Intense dreadful, horrible pain		Worst possible unbearable, excruciating pain		P value
		N	%	N	%	N	%	N	%	N	%	N	%	
Opalustre	Pre-Operative sensitivity	12	100	0	0	0	0	0	0	0	0	0	0	----
	Post operative immediately	3	25	6	50	2	16.7	1	8.3	0	0	0	0	0.005*
	After 1 month	12	100	0	0	0	0	0	0	0	0	0	0	----
	After 3 months	12	100	0	0	0	0	0	0	0	0	0	0	----
	P value	0.002*		0.005*		0.14		0.32		------		-----		
Antivet	Pre-Operative sensitivity	12	100	0	0	0	0	0	0	0	0	0	0	----
	Post operative immediately	8	66.7	3	25	1	8.3	0	0	0	0	0	0	0.008*
	After 1 month	12	100	0	0	0	0	0	0	0	0	0	0	----
	After 3 months	12	100	0	0	0	0	0	0	0	0	0	0	----
	P value	0.03*		0.06		0.32		------		-------		-------		

N: count %: percentage P: prob ability level which is significant at P ≤ 0.05.

Comparison between different time intervals (Effect of time by using Chi square test)

In Opalustre group: "no pain" (25%) was significantly the lowest post operative immediately, while "mild Pain" (50%) was significantly the highest.

In Antivet group: "no pain" (66.7%) was significantly the lowest post -operative immediately, while there was an insignificant difference between different intervals regarding all scores.

Comparison between different scores:

All patients revealed "no pain" at Pre-Operative sensitivity, After 1 month and After 3 months. In post operative immediately, in Opalustre group "mild, annoying pain" (50%) was significantly the highest, while in Antivet group," no pian" (66.7%) was significantly the highest.

Lickret scale:

Mean and standard deviation of Lickret scale in both groups were presented in figue (3).

Comparison between both groups was conducted by using Mann-Whitney's test which that the Opalustre group (2.42 ± 0.67) was significantly lower than the Antivet group (4.33 ± 0.78) as P<0.0001.

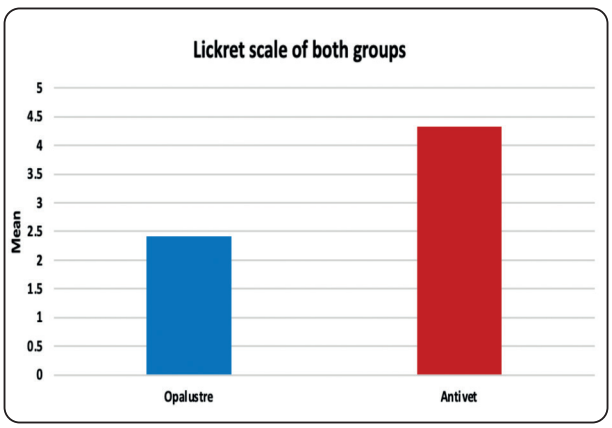

Fig. (3) Bar chart showing Lickret scale of both groups.

DISCUSSION

Many people especially children and young adults who seek dental treatment are concerned with teeth appearance and color that is considered the most esthetically important aspect [11]. Enamel defects affecting tooth color are very common in many populations in the whole world. However, a wide variation in the prevalence of such defects (2.4–40.2%) has been reported[4]. The available treatment options for discolored enamel are extensive, ranging from non-invasive, micro-invasive to macro-invasive protocols[4]. One of the commonly used treatment options for discolored enamel is microabrasion [11].

Enamel microabrasion has become a widely used nonrestorative, ultra-conservative, approach for the management of superficial enamel defects and alteration of teeth color [12]. The technique is mainly based on gentle acid etching conjugated with a rotary or manual application of abrasive material [13].

The idea of microabrasion is the use of acid for abrasive removal of the discoloration and not the dissolution of enamel stain as in bleaching [14]. It is a technique that was suggested as a treatment modality for enamel defects such as opacities; yellow, orange, brown, or enamel spots; and even fluorotic white streaks [14].

Studies have shown the presence of an "abrasion effect," by the acid erosion together with an abrasive material to tamp the inorganic tissues within the organic zone. Thus, the outer layer of prism-rich enamel is restored with a tightly condensed and prism-less zone [15].

Opalusture (6.6% hydrochloric acid) is used in the current study, to be compared with the new material Antivet (21% hydrofluoric acid) as its considered one of the most commonly used acids in microabrasion [16].

Patient satisfaction is measured by Likert scale as it is considered one of the most basic and commonly used psychometric tools in social sciences and educational research. When measuring patient satisfaction usually, there is an unlimited number of describable attitudes present in a group of people so arranging them into "clusters" of responses would be easier to measure. the presentation of an item on a scale of 5 major points allows the participants to choose easily from different alternatives [17].

In the present study, no clear differences in treatment efficacy was detected between small, medium or large stain sizes; however, efficacy was much higher in small stains. Based on the results of treatment efficacy, a complementing treatment such as bleaching or restorations was advised and performed later on to patients but this is not included in the current study.

The results of the current study showed that the Opalustre group (1.67 ± 1.72) was significantly higher in immediate post-operative sensitivity than the Antivet(0.42 ± 0.67) as $P<0.05$, while there was no sensitivity in other intervals in both groups.

There was an agreement with the current study that high teeth sensitivity with oplasture (6.6% HCL) could be highlighted to the strong nature of hydrochloric acid in contrary to antivet (21%HF) which is considered a weak acid [18].

Although the rubber cup polishing technique has proven to be less traumatic and also has more patient acceptance. But unfortunately, this was against the results of the present study. Since the rubber cup is activated and applied on the tooth surface with a constant circular movement using the abrasive particle application for a period of time, not more than 60 seconds which leads to friction and heat generation leading to less patient acceptance [19].

Zuanon et al., 2008 [20] and Tong et al., 1993 [21] agreed with current results that when microabrasion is carried out manually, less tooth structure loss and less teeth sensitivity occur when compared to microabrasion using rotary instruments.

Still, there are some controversies that need further studies, where some studies discourage placing acids on the enamel surface without mechanical application. These studies suggest that the use of rotary instruments helps to disperse and refresh the acid on the tooth surface so that the

erosive substance will not stay on the tooth surface for a long period of time, as if the acids remained in contact with the tooth structure for too long it may lead to less patient satisfaction [22, 23].

In the present study the Opalustre group, showed mean ± standard deviation of teeth sensitivity in males (0.33 ± 0.58) was significantly lower than in females (2.11 ± 1.76) at immediate postoperative, agreed with Robinson et al., 2001 [24] and Fillingim et al., 2009 [25] stating that pain endurance, tolerance and threshold was lower in females. The lower pain threshold for girls could be attributed to gender-specific changes in the perception of pain due to hormonal influences. While Schmitz et al., 2012 agreed with Antivet group results where the mean ± standard deviation of sensitivity in males (0 ± 0) was insignificantly lower than in females (0.63 ± 0.74) at postoperative immediately, as presented in Table (5). Unfortunately, there was not any link or association because pain thresholds for both genders were equal for Antivet group, since there is a dearth of articles regarding the use of Antivet [26].

Eltumi et al., and Tashani 2017, [27] agreed with the results of the present study in both groups (Antivet and Opalustre), as they concluded that there is a consistent positive linear relationship between age and pain experience. The study of Eltumi and Tashani in 2017 mentioned that the participants aged from 10 to 22 years had a significantly lower mean pain threshold than older age groups which was the age group in the current study[28].

In the current study comparison between both groups regarding patient satisfaction using the Lickert scale was performed by using Mann-Whitney's test which showed that the Opalustre group (2.42 ± 0.67) was significantly lower than the Antivet group (4.33 ± 0.78) as $P<0.0001$. this could be attributed to HF which is a weak acid, when it is in water for example, is not completely ionized as well as in acidic media as enamel into (H^+) (F^-)/ (HF) [19]. Thus, HF non-complete ionization will lead to high diffusion and penetration of the acid into the enamel although it's a weak acid, leading to better appearance and more patient satisfaction [23]. As for HCL the stronger acid which is completely ionized into (H^+) (CL^-) leads to less diffusion and penetration through the enamel [29,30]. However, the ionized form of HCL has limited lipid solubility but is highly soluble in water (hydrophilic), also having high electrical resistance, subsequently, it has a lower ability to penetrate cell membranes. Leading to less color change and less patient satisfaction[29] .

However, Loguercio et al., 2007 [30] disagreed with the results of the present study regarding Opalustre, as they performed a randomized clinical trial using a split-mouth design to compare Opaluster and PERMA in removing stains of teeth in patients suffering from fluorosis, participants in the study aged from 10 to 12 years old. The results of the study showed that approximately 97% of the participants reported satisfaction with the results of the treatment they received, with the highest improvement in appearance in Opulsture group.

There is insufficient literature about HF uses in vivo in dentistry as its mostly used in concentrations of 7.5% and 9.5% in vitro to clean metals and also as a conditioner for ceramic surfaces with glass matrix for better adhesion to resin-cements either directly before cementation or during repairs. However, its main use in vivo was as one of the ingredients of the topical fluorides. Poor and insufficient literature is available regarding microabrasion by HF [29].

Generally speaking, in all microabrasion techniques there are many factors affecting enamel loss and color improvements, such as operator's hand pressure, the type and concentration of the acid used, use of abrasives and brushes or rubber cups, and time of application; another factor which is related to the tooth itself which is the surface hardness of enamel, which is almost impossible to be measured in vivo. However, we must take into consideration the enamel thickness, which is approximately 1 mm [31]. Considering the results of other studies and the techniques used, the new material Antivet could be used successfully with a limited time period [32].

CONCLUSION

1. The current study is considered the first randomized clinical trial investigating the clinical effects of Antivet.
2. According to the results of the current study, Antivet is considered a promising alternative to products that contain HCL in the management of discolored enamel by microabrasion.

RECOMMENDATIONS:

1- Further in vitro investigations for the recent product "Antivet".

2- More clinical trials with longer follow-up periods to investigate the clinical effects of Antivet.

3- Antivet should be investigated in older age groups

4- Compare different recent microabrasive materials and their effects on enamel in correlation to acid type, acid concentration, pressure, and time procedure to achieve the best minimal invasive technique.

Conflict of interest:

"The authors declare that they have no conflicts of interest"

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