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Running title: Effect of prophylaxis technique on tooth bleaching

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Research Square

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CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	Title page, paragraph 2
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	Page 2, paragraph 1,2,3,4
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	Background, paragraph 4
	2b	Specific objectives or hypotheses	Background,

			paragraph 9,10
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	Methods, paragraph 1
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	Methods, paragraph 1
Participants	4a	Eligibility criteria for participants	Methods, paragraph 3,4
	4b	Settings and locations where the data were collected	Methods, paragraph 2
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	Methods, paragraph 7
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	Methods,

			paragraph 10
	6b	Any changes to trial outcomes after the trial commenced, with reasons	No change
Sample size	7a	How sample size was determined	Methods, paragraph 5
	7b	When applicable, explanation of any interim analyses and stopping guidelines	Methods, pragraph 6
Randomisation:			Methods, paragraph 6
	8a	Method used to generate the random allocation sequence	
Sequence generation	8b	Type of randomisation; details of any restriction (such as blocking and block size)	Methods, paragraph 6

Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	Methods,paragraph 6
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	Methods, paragraph 6
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	Methods, pragraph 6,7
	11b	If relevant, description of the similarity of interventions	Methods, paragraph 7,8
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	Methods,

			paragraph 13
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	Non
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	Figure 1
	13b	For each group, losses and exclusions after randomisation, together with reasons	Figure 1
Recruitment	14a	Dates defining the periods of recruitment and follow-up	Result, paragraph 3
	14b	Why the trial ended or was stopped	Normal period of study
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Result, paragraph 1, table 1
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	Result, paragraph 1

Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	Table 2,3,4,5
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	Non
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	Non
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	Non
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	Discussion, paragraph 9
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	Conclusion
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	Discussion, paragraph 2, 3
Other information			
Registration	23	Registration number and name of trial registry	Abstract

Protocol	24	Where the full trial protocol can be accessed, if available	Ethics approval and consent to participate
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	Funding

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

ABSTRACT

Background: The aim the study to compare the effects of pre-operative air-powder polishing and rubber-cup prophylaxis on tooth bleaching.

Methods: 23 subjects suffering from discoloration, were enrolled in a randomized controlled split mouth experimental study. Before bleaching, air powder polishing (APP) and rubber-cup polishing (RCP) techniques were applied on either side of the mouth. A 40% hydrogen peroxide bleaching agent applied two 15-minute applications for in-office bleaching. The tooth bleaching effects assessed immediately after and 1 week.

Results: There were no significant differences between prophylaxis groups with respect to all color parameters (Δ L, Δa, Δb, ΔSGU, ΔEab, Δ E00) at immediate period ($p>0,05$). At 1 week assessment period there were no significant differences between prophylaxis groups with respect to all color parameters ($p>0,05$) except delta E00 ($p<0,05$).

Conclusions: Two prophylaxis techniques produced similar efficacy in bleaching treatment and the APP technique produced higher levels of color changes.

Trial registration: ClinicalTrial.gov ID: NCT04407910

Keywords: CIELab, CIEDE2000, prophylaxis, shade guide, spectrophotometer, tooth bleaching

Background

Vital bleaching treatment in dentistry are classified as in-office bleaching and at-home bleaching. Currently, in- office bleaching gels are the most commonly used agents and contain high hydrogen peroxide concentrations (typically 15-40%) while at-home bleaching products usually contain 3-10% of hydrogen peroxide [1]. The in-office bleaching technique has some advantages such as avoiding soft tissue irritation, preventing the use of excess material and producing immediate esthetic results [2, 3].

The agents used in bleaching treatment could penetrate enamel/dentin and oxidize the molecules of the substances that cause discoloration in the tissue. In the bleaching reaction, peroxides convert into peroxide radicals, which have singular and unpaired electrons with no electronic charge. These highly reactive radicals have a high affinity for double bonds. Peroxide radicals bond to and destroy the carbon-carbon double bonds of the chromophore and either convert them into single bonds or completely break down [4]. The resulting molecules are colorless and make teeth look whiter.

Various factors are reported to effect tooth bleaching such as bleaching type, concentration, time and other factors (ie. plaque, pellicle on the tooth surface) [5]. The success of bleaching is directly related to the diffusion capacity of peroxides to enamel and dentin. The penetration of hydrogen peroxide in the tooth structure is time-dependent [6].

Up to date various studies have been performed to increase the effectiveness of the bleaching procedure in a shorter period of treatment time. In-office bleaching usually requires long application period and sometimes additional visits to obtain optimum results. Prolonging bleaching treatment may result in several side-effects such as tooth sensitivity, gingival irritation and alteration of enamel surface [7,8]. Low molecular weight of HP diffuses through permeable enamel and dentin substrates, then reaches the pulp chamber via the dentinal tubules.

Exposure to high HP concentrations, may cause inflammatory response in the pulp. Less application and sessions are recommended to minimize these side effects [9-11]. Researchers investigated whether reduced contact time of the bleaching gels could yield less-adverse effects while still being effective [10, 12, 13]. Several studies have shown that the substance released from bleaching gels is proportional to their contact time with enamel [14-17]. However, some authors have shown that exposure of pulp cells to low HP concentrations encourages the differentiation of odontoblasts and the formation of mineralization [18,19]. On the other hand, shortening the bleaching time may prevent it from achieving satisfactory results. The gel used in the in-office technique is exposed to the environment and seemingly loses water faster. This is the argument used by manufacturers to recommend applications of 15 minutes. The shortest time of application (2X15 minutes) for one session as recommended by the manufacturer was performed in the current study.

The activation of bleaching agents is limited and decreases over time [20]. Contact with plaque and external stains before tooth enamel during active time of agent might reduce its effectiveness. The superficial stains, plaque accumulation, and microorganisms formed on the outer surface of tooth enamel should be removed before starting bleaching treatment by polishing in order to make bleaching agent more effective. Dental bleaching manufacturers recommend dental prophylaxis before bleaching treatment in their instruction manuals. But there is no research about prophylaxis techniques before bleaching treatment.

The most common method of polishing is rotary rubber-cup prophylaxis with various types of pastes. These polishing pastes include flour of pumice, glycerine and fluoride. Air-powder polishing devices (APDs) are an alternative to rubber cup polishing. These devices use a slurry of water, abrasive powder and pressurized air to clean or polish tooth surface [21]. Sodium bicarbonate is the first air-polishing powder used with these devices. There are many literature

stating that air polishers are more effective and efficient in removing extrinsic stain and plaque from tooth surfaces than rubber cup polishers [22,23,24,25,26]

In addition air polishing requires less time than traditional polishing methods [27]. Polishing with a rubber cup and prophylaxis paste has been shown to remove the fluoride-rich enamel and rough the enamel [28,29].

Studies have generally found air polishing to be safe on enamel with no significant loss of enamel and less abrasive than rubber–cup polishing [30]. However marked rise in aerosols with air polishing, additional health hazards may potentially exist for patients, or health care professionals present in the treatment room during or after a procedure [31].

The aim this study is to compare the effects of pre-operative air-powder polishing and rubber-cup prophylaxis on tooth bleaching.

The null hypothesis was that there would be no difference in the change of color according to the type of prophylaxis on tooth bleaching.

Methods

This study used randomized, controlled split-mouth experimental design to compare the effects of pre-operative APD application (test side) and rubber-cup prophylaxis with paste (control side) on teeth bleaching. The flow chart of study design was given in Figure 1.

Among the patients who applied to the Cukurova University, Dental Faculty, Department of Oral Diagnosis for whitening treatment and volunteered to participate in the study and redirected to Department of Restorative Dentistry.

The inclusion criteria were:

- being at least 18 years of age
- having minimum of 20 natural teeth (including incisors, canines, and premolars in both arches)
- having good oral hygiene (Plaque index <1, Gingival index <1)

The exclusion criteria were:

- having restorations or active caries on the anterior teeth of either arch
- presence of tetracycline staining or fluorosis
- general hypersensitivity
- gingival recession or periodontal disease
- smokers
- pregnant or lactating women
- history of prior bleaching treatment

Sample size calculation

The sample size analysis for paired-sample t-test was done by G-Power package program. The sample size calculation was based on a previous study [32]. The expected mean difference of for the color change parameter between groups was 2,2 units with a standard deviation of 3,3 - 3,7 (the specified power of 80% and the Type I error rate of 5%). The calculated sample size was 21 patients while 23 patients (10% more) were included in the study to compensate possible dropouts.

Randomization

The patients had bleaching treatment on the maxillary anterior area including right and left canines. The registration of the patients has been done by Department of Oral Diagnosis and randomly allocated by ZGBK. The right and left sides of the patients were randomized by toss of a coin to receive polishing with rubber cup prophylaxis or air powder polishing system before bleaching.

Clinical procedures

Dental prophylaxis was made by a single operator (MO). The rubber cup prophylaxis was applied with low-speed handpieces. A rubber cup was attached to the prophy-angle. The handpiece used at a steady slow pace of 2500–3000 rpm. The rubber cup contacted (Pro-Cup, Light Blue, Soft, KerrHawe S.A., Bioggio, Switzerland) each tooth surface for an average of 5

seconds together with polishing paste consisting of flour of pumice, glycerin and fluoride (Cleanic, KerrHawe S.A., Bioggio, Switzerland).

The air polishing treatment was performed by AIRFLOW® Master device (EMS, Nyon, Switzerland) with a six LED power setting (2.2 bars dynamic pressure inside powder chamber) and an 11 LED (35 mL/min) water setting for 5 seconds for each tooth (powder consumption was 1.1 g). Sodium bicarbonate air-powder polishing powder (AIR-FLOW® Plus, EMS Electro Medical Systems, Nyon, Switzerland) was used. The nozzle was held 3–4 mm from the tooth surface and the tip was angulated diagonally. The spray was delivered for an average of 5 seconds using a constant circular motion for each tooth. The spray was directed towards the middle one-thirds of the exposed tooth [33].

In-office 40% HP bleaching agent (Opalescence Xtra Boost/ Ultradent, South Jordan, UT, USA) was prepared and used following the manufacturer's instructions. Opal Dam (Ultradent, South Jordan, UT, USA) was used for protection of the gingiva. The bleaching gel was then applied to form 1–2 mm thickness on the buccal surfaces of the teeth of both arches. The gel remained on teeth for 15 minutes and was then suctioned from teeth using a surgical suction tip. This application was repeated a second time in the same session.

Clinical parameters

Tooth color was measured using spectrophotometer VITA Easyshade V (Vita Zahnfabrik, Germany). All measurements were made by a single operator under same light source between 1-3 pm. The spectrophotometer was calibrated before use in each participant and the device tip was placed on middle thirds of the labial surface of teeth as suggested by the manufacturer's manual.

The tooth color was measured before initial prophylaxis (baseline), after prophylaxis, immediately after bleaching and after 1 week. The digital spectrophotometer used in the current study measures the shade of teeth based on the CIE L*a*b* color space system [34]. This system

expresses color as three values: L* for the lightness from black (0) to white (100), a* from green (−) to red (+), and b* from blue (−) to yellow (+). The following values were recorded in the units of CIE L*a*b* color space.

Color differences quantified CIELab formula (ΔEab) and CIEDE2000 formula (ΔE00).

-ΔEab calculated as: $[(\Delta L)^2 + (\Delta a)^2 + (\Delta b)2]^{1/2}$

-ΔE00 calculated as: $[(\Delta L / k L S L)^2 + (\Delta C / k C S C)^2 + (\Delta H /kHSH)^2 + RT(\Delta C^* \Delta H / SC^* SH)]^{1/2}$

Where ΔE00 is the change in color; RT is a hue rotation term; ΔL, ΔC, and ΔH are the compensation differences for neutral colors (primed values; L,C,H); SL is the compensation for lightness; SC is the compensation for chroma; SH is the compensation for hue; and kL, kC, and kH are constants and usually unity.

ΔSGU: The other bleaching scale shade guide (SGU) unit also used to monitör tooth whitting prpcess. While making SGU measurements, the bleached index is set according to the VITA Bleached guide 3D-MASTER at spectrophotometer for the measured shade. The measured bleached index after treatment was subtracted from the baseline value.

Statistical Analysis

The assumption of normal distribution of difference scores were examined prior to conducting the analysis. The assumption was considered satisfied for many differences of color scores, some of them not satisfied which were indicated with asterisk (*) in Table 1.

The proper reporting for non-normal distributed (skewed) data were summarized by using median (minimum and maximum) value instead of mean and standard deviation. Because of a consistent illustration in the Table 1 for parametric and non-parametric tests the both descriptive statistics mean ± SD, and Median (min, max) noted across all treatment levels.

The differences of color scores of the teeth were assessed for normality assumption by Shapiro-Wilks test ($p>0.05$) and homogeneity of variances were assessed by Levene's Test for Equality of variances ($p>0.05$).

The paired t-test were used if the normality assumptions were valid, otherwise the Wilcoxon-signed rank test were used to compare the rubber-cup and air-powder polishing treatments, and for the differences of 1 week and immediate values.

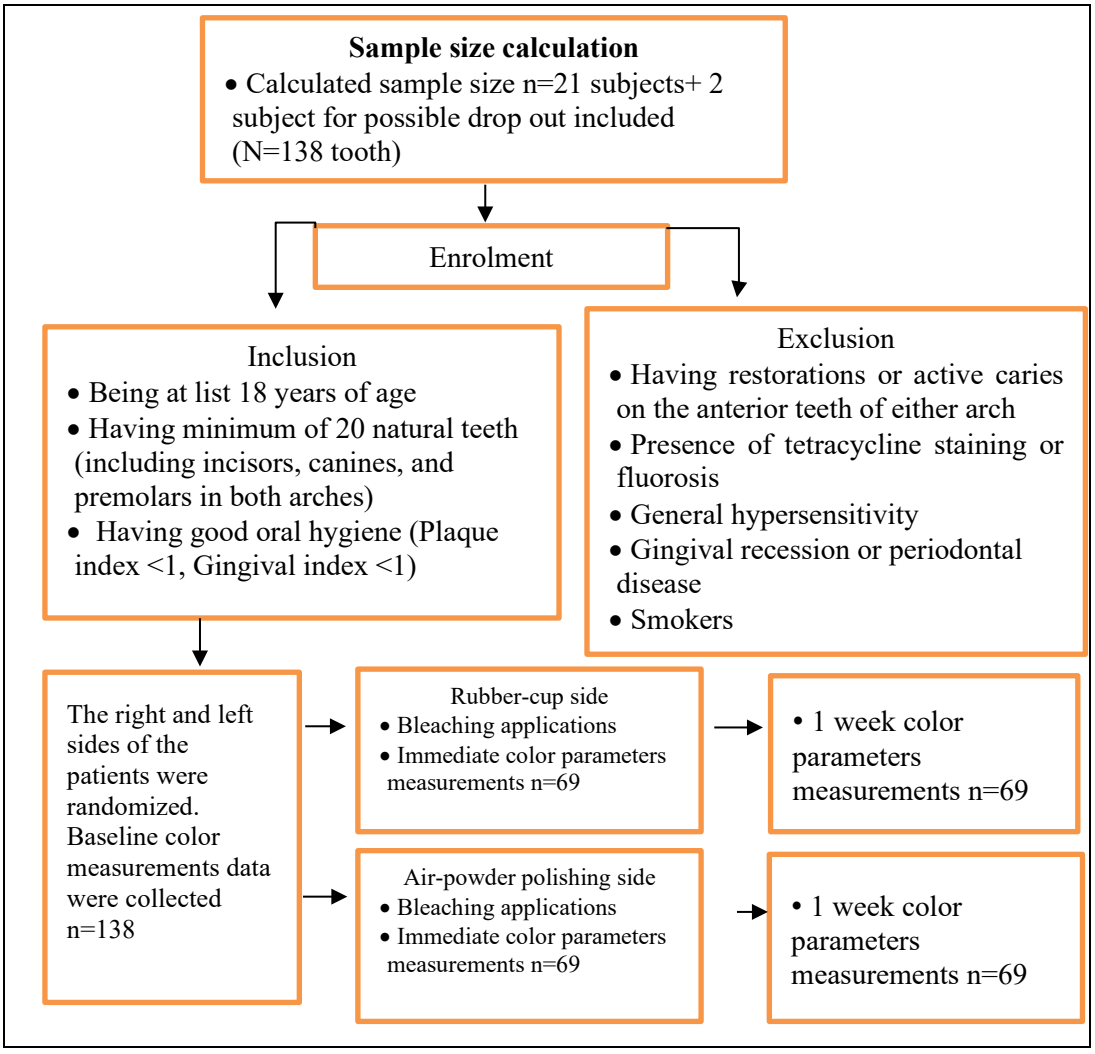


Figure 1. The flow chart of study design.

Results

All included patients completed the study protocol without any adverse events. 14 female and 9 male participated in the study. The mean age of patients was 34.1±8.9.. The baseline measurements are shown in Table 1.

After dental prophylaxis, in the RCP group were 3.177 ± 1.756 and 1.878 ± 0.957, respectively. In APP group, ΔEab and ΔE00 were 2.699 ± 1.462 and 1.569 ± 0.765, respectively. There was no significant difference at the baseline CIE L*, a*, b* value between the groups ($p>0,05$) (Table 2).

At immediate assessment period the color parameters (Δ L, Δa, Δb, ΔSGU, ΔEab, Δ E00) were significantly different assessment period ($p<0,05$). The mean ΔEab and ΔE00 and ΔSGU were 7,39±4.49 and 6,22±3.03 and 2,29±1.62 respectively in APP group and were 6,22±3.03 and 4,60±2,49 and 1,48±1.99 in RCP group respectively. While there were no significant difference between air-powder polishing and rubber-cup groups (Table 3).

At 1 week assessment period the color parameters (Δ L, Δa, Δb, ΔSGU, ΔEab, Δ E00) were significantly different assessment period ($p<0,05$). In APP group the mean ΔEab and ΔE00 and ΔSGU were 10,94±4.91 and 7,65±3,91 and 5,09±2.23 respectively, and in RCP group the mean ΔEab and ΔE00 and ΔSGU were 9,08±2.84 and 5,6±2,65 and 4,62±2.67 respectively. There was no statistically significant differences between the ARP and RCP groups for ΔEab and ΔSGU means, while ΔE00 mean difference was statistically different at 1 week period (Table 4).

When the prophylaxis groups were compared with each other for all color parameters, there was no significant difference during immediate and 1-week assessment periods.

The mean change of ΔEab, ΔSGU, ΔE00 were significant from immediate to 1-week assessment periods in air-powder polishing group and in rubber-cup group ($p<0,05$).

The mean change of ΔE00 (2,22±2,11) was significant from immediate to 1-week assessment periods in APP group, ($p < 0.001$) and also in rubber-cup group the mean change of ΔE00 (1,0±1,2) was statistically significant ($p=0.012$).

The mean change of ΔSGU (3.14±2.83) value was significant from immediate to 1-week treatment period in rubber-cup group, $p<0.001$, and also in the air-powder polishing group the mean change of SGU (2.80±1.89) was statistically significant, $p<0.001$.

Discussion

This study evaluated the influence of dental prophylaxis technique prior tooth bleaching in the change of color. Our results suggest that the dental prophylaxis technique before bleaching treatment affects the bleaching color results, thus rejecting the null hypothesis.

CIELab and CIEDE2000 have been developed to identify the color differences of objects. Studies have revealed that the ΔE2000 reflects small color differences better with the way human observers perceive [35,36].

ΔEab acceptability threshold (AT) in the literature ranges from 2.0 to 4.0, as much as half of the literature refers to its value as being 3,3 or 3,7 [37]. After dental prophylaxis, in the APP group ΔEab and ΔE00 were 3.177 ± 1.756 and 1.878 ± 0.957, respectively. In RCP group, ΔEab and ΔE00 were 2.699 ± 1.462 and 1.569 ± 0.765, respectively. Values in both groups were below ΔEab acceptability threshold. The ΔE00 acceptability threshold value was considered to be 1.8 [38]. With reference to ΔE00, the APP group was above the acceptability threshold value. There was no statistical difference between techniques in the color change of teeth after prophylaxis ($p>0,05$). Pereira et al. reported that tooth color change below the threshold values after prophylaxis with a nylon brush with prophylaxis paste [39]. This finding is similar to our results.

To our knowledge, there are no studies comparing the effects of prior APP and rubber cup prophylaxis on the bleaching effectiveness which makes the interpretation of the results

277 impossible. Results of previous study comparing the effectiveness of air-polishing to the rubber
278 cup polishing for bacterial plaque and stain removal demonstrate that both methods are equally
279 effective with similar gingival trauma [40]. While a study report APDs to be more effective for
280 plaque and stain removal in pits and fissures [41] and complete cleaning, down to the tooth
281 microstructure [42] ; another indicates that polishing with rubber cup was more effective for
282 the crown and root surface smoothening and debris removal [23]. The main disadvantage of
283 rubber-cup prohylaxis is that the polishing pastes abrade, flatten, and deposit debris into the
284 microcavities voids on the enamel surface [42] which may theoretically decrease bleaching
285 effectiveness. This may be the reason why the APP is more effective than RCP on bleaching in
286 our study. In addition, Nakamura et al. [44] reported that tooth polishing with a polishing agent
287 and a brush caused a decrease in lightness and reduction of yellowness. The polishing with
288 rubber cup and prophylaxis paste is highly operator-sensitive as rotation speed, abrasiveness of
289 paste, pressure applied with hand piece and duration influence affect the efficacy of the
290 procedure [45]. On the other hand, the aerosols generated by air polishing may present an
291 infection control hazard hence, preprocedural rinse is always recommended along with aerosol
292 reduction devices [46].
293 Previous literatures have shown that whitening from bleaching agents is manifested mainly by
294 an increase in lightness (higher L) and reduction in yellowness (lower b) and redness (lower a)
295 [47,48]. There were increase in the L value and decrease in a and b values immediately after
296 the bleaching treatment in both groups.
297 After 1 week, statistically significant developments obtained according to baseline
298 measurements in all these three values. There are significant differences in Δa and Δb values
299 in the rubber-cup group and ΔL in air-flow group from immediate to 1-week measurements.
300 Some studies found that the variance in b and L values had major influence on color change

[49,50]. In the judgement of whiteness of tooth none of a, b or L value distinctly evaluated, hence all off them equally valuable for the calculation of ΔE value.

At 1 week period there was no difference between the groups between ΔEab and ΔSGU while ΔE00 was statistically significant differences. This is due to the difference in the ΔE00 calculation technique. There are few studies on color changes after bleaching using this CIEDE2000 formula [51]. This may be because the regression lines of ΔEab on ΔE00 change from linear to curvilinear shapes when the values increases in color space. Hence in significant test we can reach different conclusion for ΔEab and ΔE00 [52].

It was reported that the bleaching activity peaked on the 7th day, therefore in our study the observations were measureed at one week after treatments [53]. ADP might benefit bleach results and patient and might be considered as the best choice for dental prophylaxis before bleaching treatment.

The split-mouth design used in this study allows different experimental groups within the same patient [54]. Thus, each patient served as his or her own control. This eliminates patient dependent variables on the results. In order to be more precise and objective, the spectrophotometer measurement was preferred over the visual evaluation [55]. Besides this, a positioning guide with orifices in the center of the middle third of teeth was fabricated [56]. This was because the middle area of teeth is generally flatter and provides a stable platform for the spectrophotometer sensor [57], and this area is the most representative tooth-color region as it reflects the light from the dentin with little influence from the enamel [56-58].

The limitations of this study are structural differences between teeth. The amount of bleaching agent that penetrates the tooth structure is affected by the thickness of enamel and dentin [59]. The CIEDE 20000 formulation is the most modern method and better reflects visual differences between colors. The use of the CIEDE 2000 formulation is recommended for future bleaching color evaluation studies.

Conclusions

The results of the study show that both rubber cup prophylaxis and APP devices can be used in fact APP may be considered as the best choice for dental prophylaxis technique before bleaching treatment.

Abbreviations

APD: Air-Powder polishing Devices, RCP: rubber-cup polishing, CIE: Commission Internationale de l'Eclairage (International Commission on Illumination), L*: Lightness, a*: Red/Green Value, b*: Blue/Yellow Value, E*: Degree of color variation, SGU: Shade Guide Units, HP: Hydrogen Peroxide, SD: Standard Deviation, LED: Light Emitting Diode, rpm: Revelution per minute, mm: millimeter

Declarations

Ethics approval and consent to participate

Informed consent forms were signed by all participants.

The protocol was reviewed and approved by Ethics Committee of Cukurova University (No: 1-6-18-78/78).

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

ZGBK developed the study outlines and coordinated the protocol. Voluntary patients registered by MO and random allocations have been done by ZGBK. All prophylaxis procedures were performed by MO. All bleaching procedures were performed by ZGBK. ZGBK was involved in measuring data and writing the first draft of the manuscript, and MO contributed to revision of the final draft. All authors read and approved the final manuscript.

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522 Table 1: Descriptive analysis before dental prophylaxis

523

	baseline	
	Mean±sd	Median (min;max)
L		
APP	70.84 ±6.00	71.20 (60.2;82.4)
RCP	71.70 ±4.14	71.40 (61.9;78.1)
p	0.592	
a		
APP	1.29 ±1.65	1.20 (-1.9;3.5)
RCP	1.28 ±1.17	1.10 (-0.6;3.4)
p	0.981	
b		
APP	24.23 ±6.31	22.60 (15.3;34.8)
RCP	24.73 ±5.71	24.7 (17.3;37.1)
p	0.604	

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529 Table 2: Color change after dental prophylaxis

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Color parameters	Mean±sd	p
ΔL		
RCP	1,850±1,359	0,500
APP	2,239±1,676	
Δa		
RCP	-0,433±0,281	0,288
APP	-0,550±0,357	
Δb		
RCP	-1,378±1,447	0,632
APP	-1,611±1,566	
ΔEab		
RCP	2,699±1,462	0,381
APP	3,177±1,756	
ΔE00		
RCP	1,569±0,765	0,295
APP	1,878±0,957	
ΔSGU		
RCP	0,7±0,58	
APP	1±0,86	0,571

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537 Table 3: Mean±standart deviations and change from baseline to immediate for ΔL, Δa, Δb,

538 ΔEab, ΔE00 and ΔSGU

Color Parameters	Mean± sd	Baseline -Immediate **p value**
ΔL		
APP	5,41±5.40	0,001
RCP	4,9±4.39	0,001
p	0,667	
Δa		
APP	-0,69±1.41	0,003
RCP	-0,15±1.26	0,003
p	0,111	
Δb		
APP	-1,56±3.96	0,001
RCP	-0,55±2.78	0,001
p	0,281	
ΔEab		
APP	7,39±4.49	
RCP	6,22±3.03	
p	0,129	
ΔE00		
APP	5,43±3,44	
RCP	4,60±2,49	
p	0,195	
ΔSGU		
APP	2,29±1.62	
RCP	1,48±1.99	
p	0,148	

539 p values in last colon belong to period differences, p values in rows belong to group differences

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Table 4: Mean±standart deviations and change from baseline to 1 week for ΔL, Δa, Δb, ΔEab, ΔE00 and ΔSGU

Color Parameters	Mean± sd	Baseline - 1 week **p value**
ΔL		
APP	8,54±5.99	0,001
RCP	5,95±4.80	0,001
p	0,153	
Δa		
APP	-0,78±2.12	0,003
RCP	-1,45±0.87	0,001
p	0.211*	
Δb		
APP	-2,38±5.40	0,001
RCP	-3,36±3.09	0,001
p	0,437	
ΔEab		
APP	10,94±4.91	
RCP	9,08±2.84	
p	0,091	
ΔE00		
APP	7,65±3,91	
RCP	5,6±2,65	
p	0,036	
ΔSGU		
APP	5,09±2.23	
RCP	4,62±2.67	
p	0,484	

APP: air-powder polishing, RCP: rubber-cup polishing

(*) Asterisk indicates the p values belong to Wilcoxon signed rank test statistics, the other p values belong to paired t-test statistics.

551 Table 5: The mean differences of color changes from immediate to 1 week period for

552 ΔL, Δa, Δb, ΔEab, ΔE00 and ΔSGU

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Color Parameters	Mean± sd	Immediate-1 week **p value**
ΔL		
APP	3,13±3.60	0,001
RCP	1,05±5.08	0,354
p	0,063	
Δa		
APP	-0,09±2.77	0.181*
RCP	-1,3±1.62	0.002*
p	0,081	
Δb		
APP	-0,82±5.26	0,484
RCP	-2,8±3.70	0,002
p	0,119	
ΔEab		
APP	3,55±3.55	<0.001
RCP	2,86±2.80	<0.001
p	0,359	
E00		
APP	2,22±2,11	<0.001
RCP	1±1,2	0.012
p	0,364	
ΔSGU		
APP	2,8±1.89	<0.001*
RCP	3,14±2.83	<0.001
p	0,591	

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555 APP: air-powder polishing, RCP: rubber-cup polishing

556 (*) Asterisk indicates the p values belong to Wilcoxon signed rank test statistics, the other p values belong to

557 paired t-test statistics.

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