Short-term effects of stain-causing beverages on tooth bleaching: A randomized controlled clinical trial

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DOI: https://doi.org/10.1016/j.jdent.2020.103318

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Short title: Staining-causing beverages on tooth bleaching

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Keywords: stain-causing beverage; colour change; effectiveness; tooth bleaching

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Abstract

Objectives: To evaluate the short-term effects of stain-causing beverages on the effectiveness of in-office tooth bleaching.

Methods: Participants were recruited and randomly divided into 3 groups based on beverages used for rinsing during and after the bleaching procedure: group N (tap water, control group), group C (coffee), and group T (tea). Participants were instructed to rinse with the respective solutions for 30 s, 4 times daily for 4 weeks. All participants received two in-office bleaching treatment sessions with 40% hydrogen peroxide (Opalescence BOOST PF 40%, Ultradent); the sessions were separated by a 1-week interval. Tooth colour was assessed using a spectrophotometer (Easyshade, Vita ZahnFabrik) before the bleaching procedure (T0), immediately after the first session of bleaching (T1), immediately after the second session of bleaching (T2), as well as one week (T3) and three weeks after (T4) the end of bleaching. Tooth sensitivity (TS) was ranked using a numerical rating scale (NRS) and a visual analogue scale (VAS) at different time points.

Results: No significant difference in the whiteness index (W), $\triangle E$, $\triangle a^*$ and $\triangle b^*$ values among the 3 groups was observed at any time interval (P for all > 0.05). At T4, the $\triangle L^*$ value in group C was significantly lower than that in groups T and N (P=0.022 and P=0.001, respectively), though no significant difference in $\triangle L^*$ values was observed among the 3 groups at T1 (P=0.402), T2 (P=0.643) and T3 (P=0.177). Additionally, no significant difference was found in the TS values among the 3 groups at any of the evaluation time points (P for all > 0.05).

Conclusions: Exposure to coffee or tea during the bleaching treatment period did not affect the effectiveness of the treatment. However, exposure to coffee after the bleaching treatment did affect the effectiveness of the treatment. Exposure to stain-causing beverages did not affect the bleaching-induced TS (ClinicalTrials.gov Identifier: NCT03933527).

Clinical Significance: The consumption of coffee or tea during tooth bleaching may not interfere with the colour change produced by the treatment. However, clinicians should advise

their patients to refrain from, at least to some extent, consuming coffee after the bleaching procedure to maintain the effectiveness of the treatment.

1. Introduction

Tooth colour is one of the most important aesthetic-related concerns of patients in modern society [1]. Dissatisfaction with tooth colour is considered the primary reason for patient dissatisfaction with their general tooth appearance [2, 3]. According to the types of discolouration, various corrective options may be considered, such as routine prophylaxis, tooth bleaching treatments, or even veneers and crowns [1, 4, 5]. As an effective and relatively conservative treatment, tooth bleaching is popular among dental professionals to treat teeth with extrinsic or intrinsic stains [4, 6]. It has been demonstrated that bleaching helps whiten teeth and produces a positive impact on oral health-related quality of life [7, 8].

However, bleaching is associated with some adverse effects, such as structural alterations, surface and subsurface demineralization, reductions in surface microhardness, and increases in the surface roughness of enamel and dentin [9-11]. The abovementioned effects may lead to greater adhesion of biofilms and pigments to bleached tooth surfaces, thus making teeth susceptible to extrinsic discolouration [12]. The main pigment-rich beverages that cause extrinsic discolouration include coffee, tea, red wine, and cola [5, 13]. These beverages are mainly acidic and have different erosive potentials according to their pH values. Along with the demineralizing and remineralizing process during the consumption of beverages, minerals and stains may be structurally incorporated into the enamel structure [14, 15]. This consideration leads to the concern that the consumption of stain-causing beverages might have a negative impact on the bleaching efficacy. Therefore, patients are advised to avoid stain-causing foods and beverages during and after bleaching treatments [16, 17]. Supporting this recommendation, a recent *in situ* study reported that the consumption of coffee and cola during at-home and in-office bleaching treatments significantly affected changes in tooth colour [14]. However, previous *in vitro* and *in situ* studies reported that exposure to coffee and red wine during the bleaching treatment period did not make the enamel more susceptible to staining [18, 19]. These 2 studies were consistent with a previous clinical study by Rezende et al [20] that suggested that exposure to stain-causing beverages during the bleaching treatment period did not compromise the aesthetic results of tooth bleaching.

As demonstrated by the somewhat conflicting results regarding the risk of staining during bleaching, there is no conclusive evidence for the effects of the consumption of stain-causing beverages after bleaching. An *in vitro* study reported that both coffee and red wine caused significant tooth colour changes compared to a control group comprising individuals who did not drink stain-causing beverages [18]. Moreover, it has been reported that pigment-rich solutions result in increased total and extrinsic discolouration of bleached teeth [21]. Nevertheless, in an *in situ* study, tooth fragments were bleached with 35% hydrogen peroxide (HP) intraorally and then immersed in a coffee solution immediately after bleaching [22]. The results indicated that avoiding coffee consumption after in-office bleaching is unnecessary, in agreement with previous *in vitro* studies [23, 24].

To the best of the authors' knowledge, no consensus regarding the necessity of avoiding the consumption of stain-causing beverages during and immediately following bleaching has been reached. Moreover, no randomized controlled clinical trial has been performed to answer this patient-related question. Therefore, the aim of this randomized controlled clinical trial was to evaluate the effect of stain-causing beverages on the effectiveness of in-office tooth bleaching and provide the highest hierarchy of evidence. The null hypotheses tested were as follows: 1) rinsing with coffee or tea during the in-office bleaching treatment period would not compromise the effectiveness of the treatment; and 2) rinsing with coffee or tea after the in-office bleaching treatment would not compromise the effectiveness of the treatment.

2. Materials and Methods

This randomized controlled clinical trial was approved by the ethics committee of the dental school of the local university and performed according to the Consolidated Standards of Reporting Trials guidelines [25], consistent with the principles of good clinical practice of the Declaration of Helsinki. This clinical trial was registered in the Clinical Trials Registry (http://www.clinicaltrials.gov) under the identification number #NCT03933527. This study was a randomized, double-blind (operator and evaluator) study. The study was carried out from February 14, 2019, to August 25, 2019.

2.1. Sample size calculation

The sample size was calculated using G-power software (University of Düsseldorf, Düsseldorf, Germany). The power for the primary outcome (ΔE) was calculated based on a two-sided *t*-test with a significance level of 5% and statistical power of 80%. The sample size was calculated to obtain a Δ E difference at the end of the study of one unit among the groups [26]. The results indicated that a minimum sample size of 19 participants was required per group. Assuming an anticipated dropout rate of 10%, the final sample size was determined to be 21 participants per group [25].

2.2. Inclusion and exclusion criteria

A total of 91 participants were examined to assess whether they met the inclusion or exclusion criteria. The inclusion criteria were as follows: 1) 18-30 years of age and in good general health [27]; 2) fully erupted maxillary incisors and canines, with no restoration; and 3) at least one maxillary anterior tooth presenting with shade A3 or darker, as measured with Vita Easyshade Advance 4.0 (Vita Zahnfabrik, Bad Säckingen, Germany). The exclusion criteria consisted of the following parameters: 1) patients with systemic diseases or oral mucosal disorders; 2) patients who were pregnant or breastfeeding; 3) patients with a known allergy to the product ingredients; 4) patients who smoked or consumed alcohol; 5) patients who underwent previous tooth bleaching treatments; 6) patients who consumed more than 3 cups of coffee or tea daily; and 7) patients undergoing orthodontic treatment.

2.3. Random sequence, allocation concealment, and blinding

Written informed consent was obtained from all participants prior to participation in the study. Participants meeting the inclusion criteria were randomly divided into 3 groups (n=21). For the allocation of the participants, a third operator who was not involved in the study protocol conducted the randomization procedure. Group allocation was performed using a computer-generated list randomly created by Microsoft Excel (Microsoft, Redmond, WA, USA).

The operator who performed the bleaching procedure was blinded to the group allocation. The evaluator, who evaluated the colour changes and tooth sensitivity (TS), was also blinded to the group allocation.

2.4. Study intervention

All of the participants received dental prophylaxis with pumice and water in a rubber cup (TPC, Advanced Technology, USA) 1 week before the experimental procedure. The participants were randomly divided into 3 groups according to the stain-causing beverages used for rinsing: coffee (group C), tea (group T), and tap water (group N, control group). The participants in all 3 groups were instructed to rinse with 50 mL of the respective solution for 30 s, 4 times daily for 4 weeks (during and after bleaching treatments). The participants in group C were instructed to rinse with a distributed bottled of finished coffee (Nescafé Smoovlatté, Nestlé, USA); those in group T were instructed to rinse with a distributed bottle of finished tea (Oolong tea, Ito En, Japan). They were instructed to start the first rinse immediately after the in-office bleaching treatment and then perform the remaining 3 rinses at 4-hour intervals during the day. The protocol was repeated at 1-week intervals. For the remaining period of the present study, the participants were requested to perform daily rinses at 4-hour intervals. All participants were asked to complete a compliance questionnaire on each day. The pH values of the solutions were measured using a pH meter (Seven Compact, Mettler-Toledo, Switzerland).

A single trained operator performed the bleaching treatments. All participants received 2 sessions of in-office bleaching using 40% HP gel (Opalescence BOOST PF 40%, Ultradent, USA) at room temperature. The gingival tissue around the teeth to be bleached was isolated

using a light-cured resin barrier (OpalDam, Ultradent, USA). The bleaching gel was freshly mixed and then applied on the maxillary anterior teeth with a 1-mm thickness in two 20-min applications according to the manufacturer's instructions. This procedure was repeated using the same protocol at 1-week intervals.

Apart from the provided beverages, other pigment-rich foods and beverages were strictly restricted in all groups during the entire study period. During the 4-week experiment, all participants were instructed to brush their teeth regularly using distributed regular toothpaste (Crest Cavity Protection, Procter & Gamble Blue Ash, USA). Participants in all 3 groups were instructed to avoid brushing their teeth for 15 min after beverage rinsing [20].

2.5. Colour evaluation

Colour evaluation was performed at baseline (T0), immediately after the first session of bleaching (T1), immediately after the second session of bleaching (T2), as well as 1 week (T3) and 3 weeks (T4) after the end of the bleaching treatment using a spectrophotometer (Vita Easyshade Advance 4.0, Vident, USA). To avoid the influence of superficial staining on the measurements of the structure colour, all participants' teeth were cleaned with water using a rubber cup (TPC, Advanced Technology, USA) before each determination. To increase the accuracy and repeatability of the measurements, an impression of the maxillary arch was taken, and a customized plastic tray with circular windows for 6 maxillary anterior teeth was fabricated for each participant [26]. Tooth colour was determined according to the Commission International Eclairage (CIE) L*a*b system [28]. The spectrophotometer was calibrated before each assessment, and three measurements were performed for each tooth. Finally, the average value of L*, a*, b* for each tooth was obtained and used to calculate the ∆L*, ∆a*, ∆b*, whiteness index (W), and colour change (∆E) values for statistical analysis. The W and ∆E values were calculated using the following formula [28]:

$$\mathrm{W} = 100 - \sqrt{(100 - {L_i}^*)^2 + {a_i}^{*2} + {b_i}^{*2}}$$

and

$$\Delta\,\mathrm{E} = \sqrt{({L_i}^* - {L_0}^*)^2 + ({a_i}^* - {a_0}^*)^2 + ({b_i}^* - {b_0}^*)^2}$$

The subscript letter “i” refers to the measurement at each testing interval, and “0” refers to the baseline measurement.

2.6. Tooth sensitivity evaluation

Participants were asked to record their perception of TS at the following time points: during the bleaching treatment and up to 1, 24 and 48 h after bleaching [29]. TS was ranked using a numerical rating scale (NRS) and a visual analogue scale (VAS) [4, 20, 29]. The NRS is a five-point verbal scale in which 0 = none, 1 = mild, 2 = middle, 3 = considerable, and 4 = severe [20, 29]. For the VAS, the scale is a 10-cm horizontal line with scores of 0 and 10 at their ends, where 0 indicates no sensitivity and 10 severe sensitivity [4, 20]. As two sessions of bleaching procedures were performed, the higher score was considered for statistical purposes [27].

2.7. Statistical analysis

Data were analysed using SPSS version 19.0 (SPSS 19.0 for Mac, SPSS, Chicago, IL, USA). The study variables were $\triangle L^*$, $\triangle a^*$, $\triangle b^*$, W, and $\triangle E$ values, which were evaluated at different time intervals. Repeated-measures analysis of variance (ANOVA) was applied to compare variables measured at different time intervals (as a repeated measure). One-way ANOVA was used to compare the intensity of TS among groups. All statistical analyses were performed at a significance level of 0.05.

3. Results

3.1. Baseline characteristics

A total of 91 participants were examined, and 63 were recruited. Two participants from groups N and T discontinued the study for personal reasons. Ultimately, 61 participants completed the study (n=20 for groups T and N, n=21 for group C). The mean baseline features of colour parameters (L*, a*, b*, and W) were similar among the groups (Table 1).

The average pH values for coffee, tea, and tap water were 5.90, 5.18, and 7.11, respectively.

3.2. Colour changes

The colour changes (△L*, △a*, △b*, W and △E) in all groups are shown in Table 2. All 3 groups achieved a whiter tooth colour, as demonstrated by increased L* and W values and decreased a* and b* values.

According to repeated-measures ANOVA, rinsing with stain-causing beverages did not produce any statistically significant effects on △L*, △a*, △b*, W or △E values (P for all > 0.05), and significant differences were observed for △L*, △a*, △b*, W and △E values among the different time intervals (P for all < 0.05). No significant interaction was found between group and time factors with regard to △a*, △b*, W and △E values (P for all > 0.05). However, a significant interaction was found between group and time factors for △L* values (P=0.010). Specifically, no significant difference in △L* value was observed among the 3 groups at T1 (P=0.402), T2 (P=0.643) and T3 (P=0.177). In contrast, the △L* value at T4 was significantly lower in group C than in groups T and N (P=0.022 and P=0.001, respectively), though no significant difference was observed between the latter 2 groups (P=0.303). Moreover, for groups T and N, the △L* value at T4 was significantly higher than that at T2 (P=0.011 and P=0.001, respectively). For group C, no significant difference in △L* value was found between T4 and T2 (P=0.324).

3.3. Tooth sensitivity

Regarding the intensity of TS, there was no significant difference among the 3 groups at any of the evaluation time points (Table 3). During bleaching and up to 1 h after bleaching,

the median value of TS among the 3 groups was between 3 and 5 according to the VAS and between 1 and 2 according to the NRS (mild or middle). Moreover, the TS value reached 0 in all 3 groups at 48 h postbleaching.

4. Discussion

Based on the present findings, the null hypothesis that rinsing with coffee after bleaching would not influence the effectiveness of bleaching was rejected. Conversely, the results failed to reject the following null hypotheses: rinsing with coffee and tea during the in-office bleaching treatment period would not influence the effectiveness of the treatment; and rinsing with tea after the in-office tooth bleaching would not influence the effectiveness of the treatment.

Tooth bleaching is frequently requested by patients, and evidence regarding the risk of consuming stain-causing beverages during and after bleaching treatment is insufficient. Importantly, the research conclusions of available studies vary, which may be partially due to differences in study designs. As mentioned above, existing studies have generally been performed *in vitro*. The exact reason for the absence of randomized clinical trials is unclear. It is speculated that this may be due to the manufacturers' recommendation, which states that stain-causing beverages should be prohibited during treatment [16, 17]. Regardless, due to the lack of direct evidence, the present study for the first time evaluated the impact of stain-causing beverages on the effectiveness of in-office bleaching using a double-blind randomized controlled clinical trial to provide the most reliable evidence [30].

Tooth discolouration is influenced not only by dietary pigments or food colourants but also by low pH media [21]. As the most popular beverages worldwide, coffee and tea are both rich in pigments and are reported to have the greatest potential to cause tooth discolouration [18, 20, 21]. The coffee and tea employed in the present study had acidic pH values, similar to those in previous studies [6, 14, 31]. The low pH value of coffee and tea might induce enamel dissolution and increase surface porosity, thus promoting tooth discolouration [32]. Moreover, anionic polyphenols, which are abundant in tea and coffee, might react with cationic salivary pellicles to form thickened layers of stained materials, subsequently causing tooth discolouration [33, 34]. Therefore, coffee and tea were selected to simulate the worst-case scenarios. Coffee manufacturers report that on average, 3.2 cups of coffee are consumed per day, and the average time for consuming a cup of coffee is 15 min [35]. Considering the

actual time it takes to swallow, the current protocol involving a 30 s rinse with coffee or tea 4 times per day was carried out to simulate the daily consumption of these beverages [20, 23, 36].

In the present study, colour was determined according to the (CIE) L*a*b system, where L* represents the lightness or darkness of the colour, and a* and b* represent measurements along the red-green axis and the yellow-blue axis, respectively [28]. All 3 groups presented markedly/extremely perceptible colour changes at the final stage (△E for all > 8) [37]. In addition, no significant difference was noted in △E and W values among the 3 groups during the entire period of the study, indicating that exposure to coffee or tea during or after bleaching did not influence the overall colour changes or the whiteness index produced by the treatment. However, considering that △E and W values are the result of the interaction of all the parameters, including △L*, △a*, and △b* values, detailed analyses were performed separately to fully assess the colour changes. When the subjects rinsed with the beverages during the bleaching treatment period, the △L*, △a*, and △b* values in all the groups were not negatively influenced, which was in accordance with previous studies [18-20]. It is possible that the bleaching treatment and enamel remineralization produced by saliva were effective in preventing tooth staining during the treatment period [18].

Nonetheless, when the solutions were used for rinsing after the bleaching treatment, group C exhibited a significantly decreased change in brightness (lowest △L*), which was consistent with a previous report [19]. Moreover, it is important to note that although a significant difference was observed, the change in brightness was minor and may not have any clinical significance. Although the coffee and tea used in the current study had similar pH values (pH=5.90 and 5.18, respectively), coffee exhibited a greater capacity to stain teeth, possibly due to its rich yellow colourant content [37, 38].

In the present study, the maximum △E and W values were observed at 1 week after the end of the bleaching treatment in all groups. Bleached teeth mainly showed changes in L* and b* values. More specifically, △b* values contributed more to the bleaching outcome than did △L* values. Different posttreatment response profiles have been reported in the literature.

For example, maximum △E or W values were obtained immediately after bleaching treatment [39], 1 week after [40, 41], and 1 month after [4, 42] in-office bleaching. Previous studies have also reported that the △b* value is the most important indicator of tooth bleaching [26, 41, 42], whereas another study considered the △L* value as a major contributor to tooth bleaching outcome [39]. The abovementioned discrepancies may be due to several factors, including differences in the study design (timing of the measurement, application methods, and other factors), study population (age, ethnicity, and other factors), and bleaching agents.This hypothesis needs to be clarified in future studies.

A low intensity of TS was observed in this study, which is in agreement with a previous study [29]. Furthermore, TS mainly occurred during bleaching and up to 1 h after bleaching and did not last longer than 48 h following the treatment. It has been reported that increased contact with drinks such as sipping and holding the liquids in the mouth should be addressed as an aetiological factor in TS [43]. In the present study, no significant difference in TS was found among the 3 groups, indicating that drinking coffee or tea during or after the bleaching treatment did not promote TS.

Based on the short-term effects of stain-causing beverages on bleaching effectiveness, shade selection at 1 to 3 weeks after bleaching treatment might be implicated. More importantly, avoiding contact with stain-causing beverages during in-office bleaching treatments seems unnecessary. Regardless, clinicians should advise their patients to refrain from, at least to some extent, consuming coffee after the bleaching procedure to maintain the effectiveness of the treatment.

Many changes are observed in teeth with increasing age, including an increase in dentin thickness, a decrease in enamel thickness, and changes in enamel and dentin structure [42]. Theoretically, participants' age may play an important role in the bleaching outcome [42] and may be responsible for the varied results reported by previous studies [4, 40]. Therefore, age limits were set in this study for the participants to control this potential variable, though the current findings need to be extrapolated to other age groups with caution. It has been reported that the duration of exposure to stain-causing beverages has a significant effect on

tooth discolouration [6]. The total staining time in the current study was relatively short, and long-term effects remain unknown, which can be considered a limitation of the present study. The other limitation concerns the compliance of the participants. It is difficult to make participants fully comply with study request, even though they were asked to complete a compliance questionnaire each day. Furthermore, the potential for and degree of staining were material-dependent [18]; hence, the current findings need to be interpreted with caution. Further evaluation considering single-variable testing may be a future research priority.

5. Conclusion

Within the limitations of this study, it can be concluded that:

1. Exposure to coffee or tea during the bleaching treatment period did not affect the effectiveness of the treatment.

2. Exposure to coffee after the bleaching treatment affected the effectiveness of the treatment.

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Table 1. Baseline characteristics of the participants included in the study

Characteristics	Group		
	C	T	N
Age (mean ± SD, y)	24.82 ± 3.65	22.45 ± 4.51	25.73 ± 2.77
L* (mean ± SD)	80.09 ± 3.66	80.00 ± 3.98	79.06 ± 4.46
a* (mean ± SD)	0.16 ± 1.35	0.34 ± 1.53	0.39 ± 1.48
b* (mean ± SD)	21.84 ± 4.84	22.78 ± 5.67	22.23 ± 5.07
W (mean ± SD)	70.22 ± 5.00	69.42 ± 5.84	69.28 ± 6.08

C, Coffee; T, Tea; N, Tap water, control group.

Table 2. Mean and standard deviation of tooth colour parameters (△L*, △a*, △b* and △E*) for all groups at different time points

Groups	C	T	N
△E value			
T1	2.83 ± 1.50^{A,a}	3.05 ± 1.91^{A,d}	2.95 ± 1.55^{A,g}
T2	5.80 ± 3.09^{B,b}	5.94 ± 3.26^{B,e}	6.04 ± 3.30^{B,h}
T3	8.41 ± 3.17^{C,c}	8.41 ± 3.67^{C,f}	8.81 ± 3.74^{C,i}
T4	8.15 ± 3.29^{D,c}	8.35 ± 3.82^{D,f}	8.43 ± 3.60^{D,j}
W value			
T1	71.09 ± 4.55^{A,a}	69.97 ± 5.30^{A,d}	70.06 ± 5.70^{A,g}
T2	75.27 ± 3.32^{B,b}	75.54 ± 3.54^{B,e}	74.57 ± 4.28^{B,h}
T3	76.53 ± 2.86^{C,c}	76.94 ± 3.25^{C,f}	77.11 ± 3.78^{C,i}
T4	76.09 ± 3.09^{D,c}	76.86 ± 3.58^{D,f}	76.98 ± 3.98^{D,i}
△L* value			
T1	1.61 ± 1.99^{A,a}	1.16 ± 2.82^{A,c}	1.42 ± 2.28^{A,f}
T2	3.37 ± 2.70^{B,b}	3.14 ± 2.72^{B,d}	3.48 ± 3.04^{B,g}
T3	3.61 ± 2.93^{C,b}	3.66 ± 3.04^{C,d}	4.31 ± 3.68^{C,h}
T4	3.07 ± 3.24^{D,b}	3.96 ± 3.38^{E,e}	4.37 ± 3.17^{E,h}
△a* value			
T1	0.19 ± 0.79^{A,a}	0.13 ± 0.65^{A,e}	-0.07 ± 0.57^{A,i}
T2	-1.13 ± 1.02^{B,b}	-1.17 ± 1.25^{B,f}	-1.22 ± 1.41^{B,j}
T3	-1.63 ± 1.08^{C,c}	-1.59 ± 1.37^{C,g}	-1.66 ± 1.14^{C,k}
T4	-1.49 ± 1.06^{D,d}	-1.42 ± 1.34^{D,h}	-1.58 ± 1.08^{D,l}
△b* value			
T1	0.22 ± 1.76^{A,a}	0.31 ± 1.80^{A,c}	0.10 ± 1.90^{A,f}
T2	-3.79 ± 2.83^{B,b}	-4.03 ± 3.10^{B,d}	-4.08 ± 2.58^{B,g}
T3	-6.90 ± 2.80^{C,c}	-6.75 ± 3.40^{C,e}	-6.90 ± 2.83^{C,h}
T4	-6.79 ± 2.84^{D,c}	-6.50 ± 3.36^{D,e}	-6.61 ± 2.76^{D,i}

C, Coffee; T, Tea; N, Tap water, control group.

T1, colour changes after the first session of the bleaching treatment;

T2, colour changes after the second session of the bleaching treatment;

T3, colour changes at 1 week after the end of the bleaching treatment;

T4, colour changes at 3 weeks after the end of the bleaching treatment.

Different uppercase letters indicate significant differences at each time point among the different groups for each colour parameter ($P<0.05$), different lowercase letters indicate statistically significant differences among the different time points in the same groups ($P<0.05$).

Table 3. Median and first and third interquartile of tooth sensitivity at different time points

Assessment time	Measurement instrument	Group		
		C	T	N
During bleaching	Visual Analogue Scale (VAS)	4 (3~4)^{A}	4 (2~6)^{A}	4 (2~5)^{A}
Up to 1 h after bleaching		5 (2.5~6)^{A}	3 (2~5)^{A}	6 (4.5~7)^{A}
Up to 24 h after bleaching		0 (0~1)^{A}	0 (0~0)^{A}	0 (0~1)^{A}
Up to 48 h after bleaching		0 (0~0)^{A}	0 (0~0)^{A}	0 (0~0)^{A}
During bleaching	Numerical Rating Scale (NRS)	2 (1~2)^{B}	2 (1~2)^{B}	1 (1~2)^{B}
Up to 1 h after bleaching		2 (1~2)^{B}	1 (1~2)^{B}	2 (1~3)^{B}
Up to 24 h after bleaching		0 (0~0)^{B}	0 (0~0)^{B}	0 (0~1)^{B}
Up to 48 h after bleaching		0 (0~0)^{B}	0 (0~0)^{B}	0 (0~0)^{B}

C, Coffee; T, Tea; N, Tap water, control group.

Different uppercase letters indicate significant differences at each time point among the different groups for each measurement instrument ($P<0.05$).

Fig. 1 Flow diagram of this randomized controlled clinical trial.