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Evaluation of the Impact of Vital Tooth Bleaching, Nonvital Tooth Bleaching, and Direct Composite Veneer Treatment Method on the Quality of Life of Patients With Tooth Discoloration in an African Population

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Abstract

Background

Tooth discoloration is a defect in tooth color that negatively affects self-esteem. Various restorative treatment methods have been shown to improve tooth color; however, few studies in the literature describe the extent to which different methods affect the quality of life of affected patients. This study therefore aimed to report the observed impact of vital tooth bleaching (VTB), nonvital tooth bleaching (NVB), and composite veneers on the oral health-related quality of life (OHRQoL) of the study participants.

Methods

A total of 111 participants with intrinsic tooth discoloration who met the inclusion criteria were consecutively recruited from the outpatient clinic of a tertiary health institution. However, at the two-week and eight-week follow-up visits, only 70 participants completed the study, while 41 were lost to follow-up, resulting in an attrition rate of 36.9%. Of these, 54 (77.1%) were managed using three major restorative treatment methods based on their clinical presentations: VTB (n = 32), direct composite veneers (DCV; n = 14), and NVB (n = 8). These participants were included in the analysis of the impact of treatment on OHRQoL. The participants managed using minor or combined treatment methods (seven groups) were too few (one to three participants per group) to constitute separate groups for analysis and were therefore excluded to avoid type II errors. The Oral Health Impact Profile for Aesthetics (OHIP-Aesthetics) questionnaire was used to collect data on the impact of the different treatment methods on patients' quality of life at two and eight weeks after treatment. Data were analyzed using SPSS for Windows, version 16.0 (released 2007; SPSS Inc., Chicago, IL, USA). Categorical variables were summarized using frequencies and percentages. The OHIP-Aesthetics domain scores and overall score were summarized descriptively using means and SEMs, as reported in the original study.

Results

A total of 32 participants (45.7%) were treated with VTB, 14 (20.0%) with DCV, and eight (11.4%) with NVB. At two weeks after treatment, the overall mean OHIP-Aesthetics score decreased from 28.25 ± 2.04 to 16.41 ± 1.65 in the VTB group, from 29.50 ± 3.25 to 11.75 ± 1.46 in the NVB group, and from 31.50 ± 2.84 to 9.43 ± 1.56 in the DCV group. At eight weeks, the corresponding scores decreased further in all groups to 12.19 ± 1.69, 5.75 ± 2.28, and 7.64 ± 1.88, respectively. Among participants in the VTB group, an initial increase in the mean physical pain score was observed at two weeks; however, lower physical pain scores were observed at eight weeks.

Conclusions

All three major restorative treatment groups were associated with improvements in OHRQoL at two and eight weeks after treatment. This was inferred from the substantial reductions in OHIP-Aesthetics scores at the two-week and eight-week follow-up assessments. At two weeks, an initial increase in the physical pain domain was observed in the VTB group, as well as increases in the psychological, social disability, and physical pain domains in the NVB group. However, by eight weeks, all groups showed reductions across all domains and in the overall OHIP-Aesthetics score. The observed differences should be interpreted descriptively because an appropriate retrospective inferential analysis could not be performed using the available aggregate data.

Categories: Family/General Practice, Public Health, Dentistry

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Keywords: composite veneers, nonvital tooth bleaching, quality of life, tooth discoloration, vital tooth bleaching

Introduction

Tooth discoloration is a dental anomaly that diminishes dental aesthetics and lowers self-esteem and psychosocial well-being [1]. Studies have reported that it negatively affects the quality of life of affected individuals [2,3]. Various factors influence psychological well-being, including age, socioeconomic status, and gender. However, the ultimate determinant of psychosocial recovery in affected individuals is the correction of the deformity [4].

Restorative dentistry has evolved over the decades alongside advances in science. Dental materials designed and developed to address various dental needs have improved to better address aesthetic challenges [5,6]. Various restorative interventions are available for treating intrinsic tooth discoloration. These include bleaching (vital and nonvital), microabrasion and macroabrasion, veneers (both direct and indirect), and full-coverage crowns. These interventions have been reported to significantly improve the well-being of affected individuals [7].

Restorative treatment has been reported to significantly improve tooth color, thereby enhancing patients' quality of life. Several factors determine the appropriate restorative treatment for a discolored tooth or teeth, including the etiological factors, clinical presentation of the discolored tooth or teeth, number of teeth affected, history of allergy to dental materials, and patient preferences. Moreover, some procedures require a longer time to complete, whereas others depend entirely on patient compliance to achieve optimal results, such as nightguard bleaching techniques. Other procedures may cause postoperative dentin hypersensitivity, all of which may reduce the quality of life of patients undergoing these procedures [8-11].

The impact of different restorative treatment methods has not previously been reported in resource-constrained settings such as Nigeria in sub-Saharan Africa. Therefore, this study aimed to evaluate the impact of vital tooth bleaching (VTB), nonvital tooth bleaching (NVB), and direct composite veneers (DCV) on the quality of life of patients treated for intrinsic tooth discoloration in this population. The results of this study may aid patient education before treatment, guide patient expectations, and help validate the effectiveness of the selected treatment methods.

Materials And Methods

Study design, setting, and participant selection

This study was conducted at the Conservative Dentistry Clinic, Department of Restorative Dentistry, University of Benin Teaching Hospital, Benin City, Nigeria. It was a prospective, nonrandomized interventional (quasi-experimental before-and-after) study aimed at evaluating the impact of different restorative methods for treating intrinsic tooth discoloration. The study was conducted between November 2012 and June 2013.

The sample size was determined using the Cochrane statistical formula, also known as Fisher's formula [12]:

$$n_0 = \frac{Z^2 pq}{d^2},$$

where n is the minimum sample size when the population is greater than 10,000; Z is the standard normal deviate, set at 1.96 for a 95% confidence level; p is the estimated prevalence or proportion representing a key variable in the research problem, estimated at 6% (0.06) [13]; q = 1-p, with p and q being complementary proportions; and d is the maximum acceptable margin of error, set at 5% (0.05). The calculated sample size was 86.63, approximately 87.

The sample size was then adjusted for a population smaller than 10,000 using the finite population correction formula [12]:

$$n_f = \frac{n_0}{1 + \frac{n_0 - 1}{N}} = 53.70 \approx 54,$$

where nf is the adjusted sample size, n is the calculated sample size for a population greater than 10,000 (an infinite population), and N is the average monthly patient population at the restorative clinic of the University of Benin Teaching Hospital, which was 138. The adjusted sample size was 53.70, approximately 54.

A minimum sample size of 54 was calculated, and 10% was added to account for attrition, resulting in a target sample size of approximately 59. However, a total of 111 participants were recruited to improve

statistical power and the robustness of the statistical analyses. Participants were consecutively recruited from patients presenting for restorative procedures who met the selection criteria and were willing to participate. No randomization was performed during participant selection because patients were recruited consecutively. The inclusion criteria were intrinsic tooth discoloration that had not been previously treated and an age greater than 16 years. Ethical approval was obtained from the institution's ethics committee (approval number: ADM/E 22/A/VOL. VII/782), and written informed consent was obtained from all participants.

Clinical records

A detailed relevant medical and dental history was obtained for each patient. Extraoral and intraoral examinations were performed, and intraoral radiographs and sensibility tests were obtained when indicated. Tooth shade was assessed using both a visual method (Vita Shade Classical, VITA Zahnfabrik, Bad Säckingen, Germany) and an instrumental method (dental colorimeter).

Types of restorative treatment performed

Treatment options were selected based on the etiological factors, clinical presentation, and availability of the most appropriate treatment. All patients were referred for full-mouth scaling and polishing before definitive treatment, except those with a recent history of professional cleaning and good oral hygiene. The treatment duration depended on the type of procedure. Home VTB required two weeks per session. The severity of discoloration determined the number of sessions recommended for VTB; however, a maximum of three sessions was performed in this study.

VTB

The nightguard VTB technique was used to manage patients with tetracycline stains of varying degrees, mild and moderate fluorosis (according to Dean's classification) [14], age-related discoloration, and discoloration due to pulp calcification without radiographic or clinical signs or symptoms. It was also used for intracoronal and extracoronal bleaching.

Technique: Individualized, custom-made trays (bleaching trays (BTs) or matrices) were fabricated from thermoforming sheets using the patient's dental cast (jaw model). The sheets were heated and shaped using a vacuum-forming machine and then trimmed to fit. Instructions for home use were provided. Patients were instructed to wear the BT just before going to bed and to brush their teeth before inserting it. They were instructed to apply the bleaching agent (Whitesmile 22% CP, WHITEsmile GmbH, Birkenau, Germany) to the inner surfaces of the tray that would contact the labial surfaces of the discolored teeth only. They were also instructed to avoid eating, speaking, or performing other active oral functions while wearing the tray; to avoid strongly pigmented or oily foods, tea, coffee, and similar products for at least two hours after removing the tray; and to wash the tray daily before use. The bleaching gel was to be stored in a refrigerator or a cool place but not frozen.

Intracoronal/NVB ("Walking Bleach")

This method was used for discolored, nonvital teeth requiring root canal treatment or teeth that had previously undergone adequate root canal treatment without current periapical pathology.

Technique: Radiographic reassessment was performed for all root-treated teeth to determine the adequacy of treatment and the current status of the periapical tissues. If the findings were satisfactory, an access cavity was prepared using a high-speed handpiece and a round bur to reduce the filling material in the cavity and pulp chamber to the cementoenamel junction (CEJ). The coronal gutta-percha was reduced to 1-2 mm below the CEJ using an appropriately sized Gates-Glidden bur. Glass ionomer cement (GIC), approximately 1-2 mm thick, was placed over the reduced gutta-percha to create a cervicoapical seal. Sodium perborate was mixed to a putty-like consistency and placed in the pulp chamber. A moist cotton pellet was placed over the material, or cotton wool impregnated with sodium perborate solution was placed in the chamber before temporary cement was applied. Zinc phosphate or zinc polycarboxylate cement was used as the temporary restoration. The sodium perborate dressing was changed at three- to four-day intervals until the tooth had whitened to approximately one shade lighter than the adjacent tooth. GIC and composite resin were used for the final restoration once the desired shade was achieved.

Intracoronal and Extracoronal Bleaching

This procedure was performed in patients with nonvital, root-treated teeth. It involved using a bleaching matrix, that is, the nightguard technique, and the walking bleach technique simultaneously.

Enamel Microabrasion

In this study, microabrasion was used as an adjunct to composite veneer treatment in patients with

moderate fluorosis and enamel hypocalcification.

Technique: After isolation and placement of a cheek and lip retractor, a slurry of pumice and 37% phosphoric acid was applied to the affected tooth surfaces using a rubber cup on a slow-speed handpiece for approximately five to seven seconds. The slurry was then rinsed off with a water jet for three to four seconds. The process was repeated six to seven times per tooth. Each tooth was polished with polishing paste for one minute, rinsed, and air-dried before the next phase of treatment.

Enamel Macroabrasion

Macroabrasion was performed as an adjunct to composite veneer treatment in some patients with enamel hypoplasia and severe fluorosis.

Technique: A tapered fissure diamond finishing bur attached to a high-speed handpiece was used intermittently at moderate speed to remove superficial layers of discolored enamel under operating light, with water spray and suction. The depth of visible discoloration was assessed intermittently to avoid excessive enamel removal. After reshaping and recontouring the enamel, the tooth was air-dried before the next phase of treatment.

Composite Veneer

DCV were placed in patients with enamel hypoplasia and severe tetracycline staining.

Technique: After shade selection, tooth preparation was performed using a tapered fissure diamond bur under water spray and suction. The window technique was primarily used when a full veneer was indicated. In patients with partial discoloration and structural defects, such as pits and grooves, minimal enamel reduction and recontouring were performed before composite placement. An incremental layering technique was used, combining shades by overlaying darker shades with lighter ones. This technique also allowed adequate curing of the composite resin. When dentin was exposed, GIC was first placed over the exposed surfaces before composite veneering (the sandwich technique). Finishing and polishing were performed, and post-restorative instructions were provided. These included avoiding highly chromogenic foods and beverages for 24 hours after the procedure, using straws when consuming highly chromogenic drinks thereafter, and undergoing scaling and polishing every six months, among other recommendations.

Full Coverage Crowns

Patients with nonvital teeth complicated by weakened or fractured crowns were treated using full-coverage crowns. Porcelain-fused-to-metal (PFM) crowns were fabricated following clinical tooth preparation and temporization.

Technique: Shade selection was performed using the Vita shade guide (Vitapan Classical, VITA Zahnfabrik) with an adjacent tooth of normal color serving as a reference under natural daylight. The selected shade was recorded on a job card. Under operating light, local anesthesia was administered using 1.8 mL of lignocaine with adrenaline at a concentration of 1:80,000 to anesthetize the surrounding soft tissues during tooth preparation. Clinical crown preparation was performed according to the reduction guidelines for PFM crowns. Elastomeric impressions were taken using well-fitting impression trays. The impressions were rinsed under running water, disinfected with glutaraldehyde solution, and sent to the dental laboratory with a completed job card requesting fabrication of a PFM crown. The prepared tooth was temporized using a suitably sized polycarbonate temporary crown cemented with zinc oxide-eugenol cement. The occlusion was checked for interferences, and necessary adjustments were made. Post-cementation instructions were provided, and a new appointment was scheduled for delivery of the permanent crown. At the next appointment, the permanent crown was tried in, necessary adjustments were made, and the crown was cemented using GIC (Vitro Cem, DFL, Rio de Janeiro, Brazil). Post-cementation instructions were provided.

Combination Treatments

Microabrasion and VTB: This combination was used to manage cases of moderate fluorosis. Microabrasion and DCV were recommended for patients with enamel hypocalcification defects and severe fluorosis.

Macroabrasion and composite veneers: This combination was used for most patients with enamel hypoplasia. Both procedures were performed during the same visit.

The combined techniques were performed during the same visit on the designated tooth or teeth.

VTB and composite veneer: The results also indicated that some patients were unwilling to continue VTB for an extended period. Composite veneers were placed over the bleached enamel seven days after completion of tooth bleaching. This interval was intended to prevent bond failure between the composite resin and

enamel due to the inhibitory effect of residual oxygen released during tooth bleaching on composite resin polymerization.

Regardless of the treatment type, all patients were reviewed at two and eight weeks after treatment for data collection.

Data collection and analysis

Before treatment and at the scheduled follow-up assessments, participants completed the Oral Health Impact Profile for Aesthetics (OHIP-Aesthetics) questionnaire [15]. The OHIP-Aesthetics was derived from the OHIP-49 questionnaire developed by Slade and Spencer [16] and is organized into seven dimensions: the functional limitation domain (measuring difficulties with chewing or speaking due to aesthetic conditions); the physical pain domain (measuring pain or discomfort in the teeth, such as sensitivity resulting from tooth discoloration treatment); the psychological discomfort domain (measuring feelings of tension, self-consciousness, or embarrassment about the appearance of the teeth); the physical disability domain (measuring avoidance of certain foods or difficulties eating due to aesthetic treatment procedures); the psychological disability domain (measuring poor self-esteem or loss of confidence due to dental appearance); the social disability domain (measuring difficulties in social life, such as avoiding smiling or social interactions); and the handicap domain (measuring the overall impact, such as reduced ability to work or study due to dental aesthetics).

Responses were scored on a 5-point Likert scale ranging from 0 (“never”) to 4 (“very often”): 0 = never, 1 = hardly ever, 2 = occasionally, 3 = fairly often, and 4 = very often. Each domain contained two questions, yielding a possible score of 0-8 per domain. Higher scores indicated poorer oral health-related quality of life (OHRQoL), whereas lower scores indicated better OHRQoL. Formal permission to use the OHIP-Aesthetics in this study was obtained from the original copyright holders.

Data were analyzed using SPSS for Windows, version 16.0 (released 2007; SPSS Inc., Chicago, IL, USA). Categorical variables were summarized using frequencies and percentages. The OHIP-Aesthetics domain scores and overall score were summarized descriptively using means and SEMs, as reported in the original study.

The original analysis used paired-sample t-tests to compare pre- and posttreatment OHIP-Aesthetics scores. However, the distribution of the paired differences was not formally assessed, and the appropriateness of the parametric approach was particularly uncertain for the small NVB group (n = 8). Following a methodological review, the original paired-sample t-test results were not retained in the revised presentation because individual participant-level paired observations were no longer available for retrospective reanalysis. Consequently, neither the Wilcoxon signed-rank test nor the Shapiro-Wilk test could be validly performed using the available aggregate summary statistics. The revised analysis therefore presents the observed pre- and posttreatment mean scores and the corresponding observed mean changes descriptively. Statistical significance was not assigned to these observed changes in the revised analysis.

Results

A total of 111 participants with intrinsic tooth discoloration who met the inclusion criteria were consecutively recruited from the hospital’s outpatient clinic. However, only 70 participants (46 females and 24 males; Figure *1*) completed the study and attended the two-week and eight-week follow-up visits, while 41 participants were lost to follow-up, resulting in an attrition rate of 36.9% (Figure *2*). The baseline sociodemographic and clinical characteristics of participants lost to follow-up (noncompleters) were similar to those of participants who completed the study (completers).

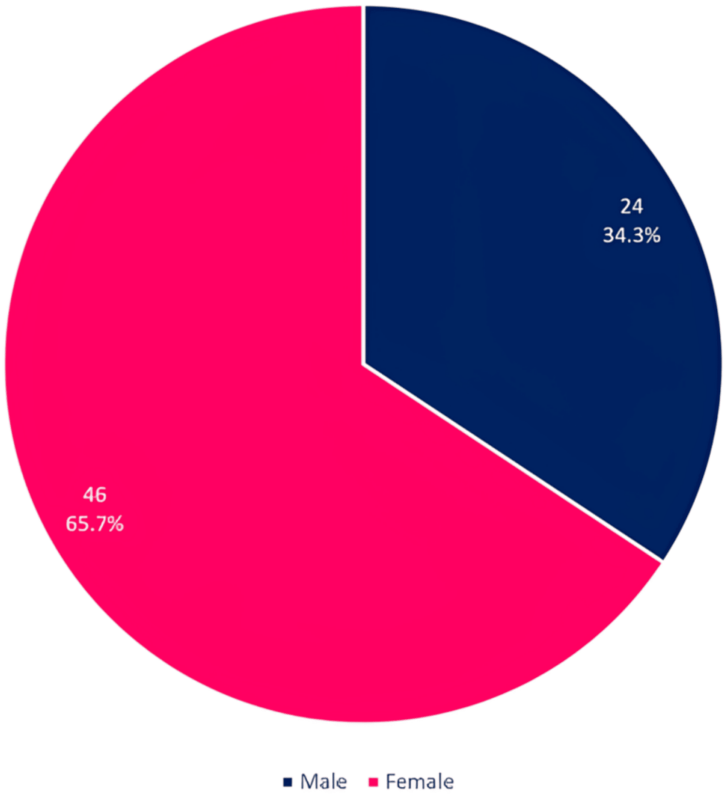


FIGURE 1: Gender distribution of participants (n = 70).

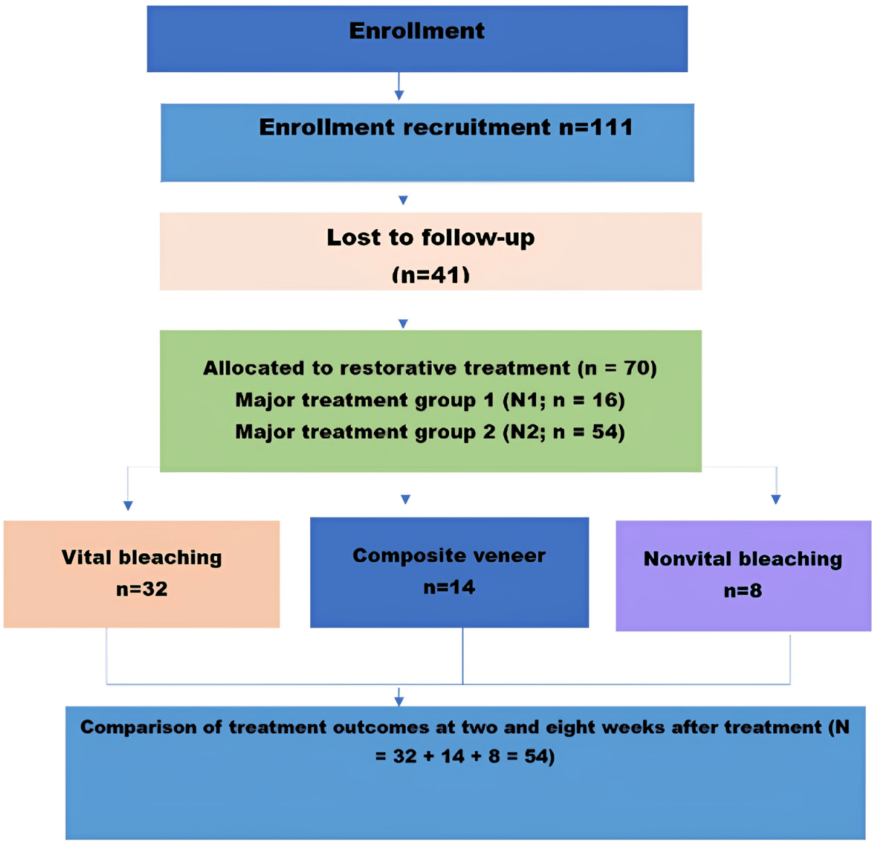


FIGURE 2: CONSORT diagram showing the flow of participants through the study.

The participants' ages ranged from 17 to 52 years, with an overall mean age of 26.80 ± 6.75 years. The mean age was 26.58 ± 6.21 years among male participants and 26.91 ± 7.08 years among female participants. The largest proportion of participants (32.9%) were aged 26-30 years (Figure 3).

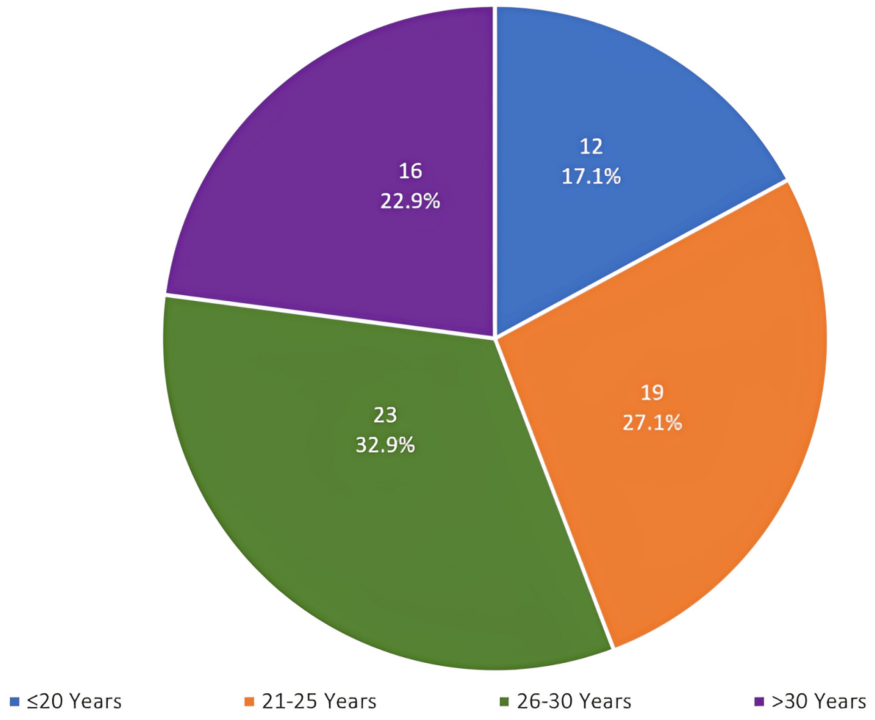


FIGURE 3: Age distribution of participants (n = 70).

Fifty-four participants (77.1%) received one of three major restorative treatments, selected based on the etiology of discoloration and clinical presentation: VTB (32 participants, 45.7%), DCV (14 participants, 20.0%), and NVB (8 participants, 11.4%) (Table *1*). The remaining participants received other treatment modalities or combinations of treatments, with few participants in each group: macroabrasion and composite veneer (n = 1), microabrasion and composite veneer (n = 4), microabrasion, macroabrasion, and composite veneers (n = 1), microabrasion and VTB (n = 2), VTB and composite veneers (n = 3), full-coverage crowns (n = 3), and intracoronal and extracoronal bleaching (n = 2) (Table *2*). These smaller treatment groups were excluded from the between-group analysis because of their small sample sizes.

Treatment modality	Frequency (n)	Percentage (%)
VTB only	32	59.3
NVB only	8	14.8
Composite veneer only	14	25.9
Total	54	100

TABLE 1: Distribution of participants in the three major treatment groups (n = 54).

NVB, nonvital tooth bleaching; VTB, vital tooth bleaching

Treatment	Frequency (n)	Percentage (%)
VTB	32	45.7
NVB	8	11.4
Composite veneer	14	20.0
Macroabrasion and composite veneer	4	5.7
Microabrasion and composite veneer	1	1.4
Micro- and macroabrasion and composite veneer	1	1.4
Microabrasion and VTB	2	2.9
VTB and composite veneer	3	4.3
Full coverage crown	3	4.3
Intracoronal and extracoronal bleaching	2	2.9
Total	70	100

TABLE 2: All types of treatment rendered to participants.

NVB, nonvital bleaching; VTB, vital tooth bleaching

Those treated with VTB alone reported the highest percentage of hypersensitivity (12 (37.5%); Table *3*).

Treatment modality	Asymptomatic, n (%)	Sensitivity, n (%)	Sensitivity and soreness, n (%)	Total, n
VTB	18 (56.3)	12 (37.5)	2 (6.3)	32
NVB only	8 (100.0)	0 (0.0)	0 (0.0)	8
Composite veneer	12 (85.7)	2 (14.3)	0 (0.0)	14
Total	38 (70.4)	14 (25.9)	2 (3.7)	54

TABLE 3: Posttreatment symptoms among participants in the three major treatment groups at two weeks after treatment (n = 54).

Participants treated with VTB had the highest proportion of reported hypersensitivity (12/32, 37.5%).

NVB, nonvital bleaching; VTB, vital tooth bleaching

At two weeks after treatment, reductions in the overall OHIP-Aesthetics mean score were observed in all three major treatment groups. Among participants treated with VTB, the overall mean score decreased from 28.25 ± 2.04 before treatment to 16.41 ± 1.65 at two weeks, an observed reduction of 11.84 points. Among participants treated with NVB, the overall mean score decreased from 29.50 ± 3.25 to 11.75 ± 1.46, an observed reduction of 17.75 points. Among participants treated with DCV, the score decreased from 31.50 ± 2.84 to 9.43 ± 1.56, an observed reduction of 22.07 points.

At the domain level, reductions in mean scores were observed across most domains in all three treatment groups. An exception was the physical pain domain among participants treated with VTB, in which the mean score increased from 2.09 ± 0.35 before treatment to 2.38 ± 0.28 at two weeks, an observed increase of 0.29 points. The pretreatment and two-week scores and observed changes are presented in Table *4*.

OHIP-Aesthetics domain	VTB pre	VTB post 1	VTB observed change	NVB pre	NVB post 1	NVB observed change	DCV pre	DCV post 1	DCV observed change
Functional limitation	6.53 ± 0.35	3.41 ± 0.32	-3.12	7.50 ± 0.38	2.25 ± 0.41	-5.25	6.50 ± 0.48	2.07 ± 0.25	-4.43
Physical pain	2.09 ± 0.35	2.38 ± 0.28	0.29	2.63 ± 0.98	1.38 ± 0.26	-1.25	2.86 ± 0.59	1.21 ± 0.30	-1.65
Psychological discomfort	5.34 ± 0.39	2.91 ± 0.39	-2.43	5.88 ± 0.79	2.13 ± 0.23	-3.75	6.21 ± 0.47	1.71 ± 0.27	-4.50
Physical disability	2.96 ± 0.33	1.75 ± 0.21	-1.21	3.88 ± 0.83	1.50 ± 0.33	-2.38	3.00 ± 0.28	0.79 ± 0.24	-2.21
Psychological disability	4.66 ± 0.38	2.53 ± 0.37	-2.13	4.38 ± 0.46	1.75 ± 0.41	-2.63	4.50 ± 0.58	1.29 ± 0.29	-3.21
Social disability	2.47 ± 0.38	1.44 ± 0.27	-1.03	2.13 ± 0.40	1.38 ± 0.46	-0.75	3.86 ± 0.77	1.21 ± 0.30	-2.65
Handicap	4.19 ± 0.42	2.00 ± 0.27	-2.19	3.13 ± 0.81	1.38 ± 0.46	-1.75	4.57 ± 0.76	1.14 ± 0.35	-3.43
Overall OHIP-Aesthetics	28.25 ± 2.04	16.41 ± 1.65	-11.84	29.50 ± 3.25	11.75 ± 1.46	-17.75	31.50 ± 2.84	9.43 ± 1.56	-22.07

TABLE 4: Relative impact of VTB, NVB, and composite veneer treatment on OHIP-Aesthetics scores two weeks after treatment.

Statistical presentation: Descriptive pretreatment and two-week posttreatment means ± SEM are reported. The observed change was calculated as the posttreatment mean minus the pretreatment mean. No inferential p-values are reported because participant-level paired observations were unavailable for retrospective nonparametric analysis.

Values are mean ± SEM, as reported in the original study. Observed change = posttreatment mean - pretreatment mean. Negative values indicate a reduction in OHIP-Aesthetics score. Pre = before treatment; post 1 = two weeks after treatment. VTB, n = 32; NVB, n = 8; DCV, n = 14. No inferential p-values are reported because participant-level paired observations required for appropriate nonparametric reanalysis were unavailable.

NVB, nonvital bleaching; OHIP-Aesthetics, Oral Health Impact Profile for Aesthetics; VTB, vital bleaching

At eight weeks after treatment, reductions in the overall OHIP-Aesthetics mean score were observed in all three major treatment groups. Among participants treated with VTB, the overall mean score decreased from 28.25 ± 2.04 before treatment to 12.19 ± 1.69 at eight weeks, an observed reduction of 16.06 points. Among participants treated with NVB, the score decreased from 29.50 ± 3.25 to 5.75 ± 2.28, an observed reduction of 23.75 points. Among participants treated with DCV, the score decreased from 31.50 ± 2.84 to 7.64 ± 1.88, an observed reduction of 23.86 points.

At the domain level, lower mean scores were observed at eight weeks than at baseline across all domains in each of the three treatment groups. In the physical pain domain, the mean score among participants treated with VTB decreased from 2.09 ± 0.35 at baseline to 1.63 ± 0.20 at eight weeks. The corresponding decrease was from 2.63 ± 0.98 to 0.75 ± 0.37 in the NVB group and from 2.86 ± 0.59 to 1.36 ± 0.29 in the DCV group. Detailed pretreatment and eight-week scores are presented in Table 5.

OHIP-Aesthetics domain	VTB pre	VTB post 2	VTB observed change	NVB pre	NVB post 2	NVB observed change	DCV pre	DCV post 2	DCV observed change
Functional limitation	6.53 ± 0.35	2.53 ± 0.32	-4.00	7.50 ± 0.38	1.13 ± 0.32	-6.37	6.50 ± 0.48	1.50 ± 0.25	-5.00
Physical pain	2.09 ± 0.35	1.63 ± 0.20	-0.46	2.63 ± 0.98	0.75 ± 0.37	-1.88	2.86 ± 0.59	1.36 ± 0.29	-1.50
Psychological discomfort	5.34 ± 0.39	2.31 ± 0.38	-3.03	5.88 ± 0.79	0.88 ± 0.35	-5.00	6.21 ± 0.47	1.29 ± 0.38	-4.92
Physical disability	2.96 ± 0.33	1.19 ± 0.23	-1.77	3.88 ± 0.83	0.63 ± 0.26	-3.25	3.00 ± 0.28	0.86 ± 0.35	-2.14
Psychological disability	4.66 ± 0.38	2.56 ± 0.74	-2.10	4.38 ± 0.46	0.88 ± 0.35	-3.50	4.50 ± 0.58	1.14 ± 0.46	-3.36
Social disability	2.47 ± 0.38	0.84 ± 0.19	-1.63	2.13 ± 0.40	0.88 ± 0.40	-1.25	3.86 ± 0.77	0.64 ± 0.25	-3.22
Handicap	4.19 ± 0.42	1.13 ± 0.23	-3.06	3.13 ± 0.81	0.63 ± 0.32	-2.50	4.57 ± 0.76	0.86 ± 0.33	-3.71
Overall OHIP-Aesthetics	28.25 ± 2.04	12.19 ± 1.69	-16.06	29.50 ± 3.25	5.75 ± 2.28	-23.75	31.50 ± 2.84	7.64 ± 1.88	-23.86

TABLE 5: Relative impact of VTB, NVB, and composite veneer treatment on OHIP-Aesthetics scores eight weeks after treatment.

Statistical presentation: Descriptive pretreatment and eight-week posttreatment means ± SEM are reported. The observed change was calculated as the posttreatment mean minus the pretreatment mean.

Values are mean ± SEM, as reported in the original study. Observed change = posttreatment mean - pretreatment mean. Negative values indicate a reduction in OHIP-Aesthetics score. Pre = before treatment; post 2 = eight weeks after treatment. VTB, n = 32; NVB, n = 8; DCV, n = 14. No inferential p-values are reported because participant-level paired observations required for appropriate nonparametric reanalysis were unavailable

NVB, nonvital bleaching; OHIP-Aesthetics, Oral Health Impact Profile for Aesthetics; VTB, vital bleaching

Discussion

In this study, 10 different restorative methods were used to treat tooth discoloration, of which three were single methods, and the other seven were combinations of methods. The three major single methods of treatment were VTB, NVB, and DCV. The number of participants treated in the combination treatment groups was small; hence, these groups were excluded from the final statistical analysis of the different treatment methods to avoid type II statistical error (false-negative error). Therefore, only the three major treatment groups were analyzed to assess the impact of the treatment method. This decision was made post hoc.

Most participants (45.7%) were treated with the VTB (nightguard bleaching) technique. This may be because tooth bleaching is one of the most conservative ways to treat tooth discoloration, particularly in cases of multiple and generalized intrinsic discoloration. It has also been reported to be an effective treatment method [17,18].

In this study, composite veneers (20%) were the next most frequently used treatment method. This may be related to the proportion of participants who presented with clinical structural loss. Intrinsically discolored teeth complicated by enamel and dentinal defects require structural buildup in addition to a color change. Hence, in this study, DCV were used for cases presenting with both discoloration and enamel defects. Emmanuel [18], in a 20-year retrospective review, reported that dental composite veneers were a viable treatment option, with a demonstrated survival rate of five to seven years. The next most frequently used method was NVB (11.4%). Most single teeth presenting with intrinsic discoloration were devitalized and located in the anterior segment of the dental arch. This may be due to the increased susceptibility of anterior teeth to trauma. Following root canal treatment, NVB is an appropriate treatment for discoloration in such cases. Deepika et al. [19], in a case series of patients treated with NVB, reported satisfactory results after treatment and at follow-up visits. The two least frequently used treatment methods were full-coverage crowns and the combination of extracoronal and intracoronal bleaching techniques. Full-coverage crowns are relatively expensive and invasive. Moreover, they are mainly indicated for cases involving substantial

weakness or structural loss or an unsatisfactory response to bleaching. In this study, only three participants required full-coverage crowns. Similarly, combined intracoronal and extracoronal bleaching is usually indicated for cases of nonvital tooth discoloration that respond poorly to bleaching. In this study, only one case (2.9%) met this criterion.

Following treatment, some participants reported sensitivity and soreness, either separately or in combination with sore gums (sensitivity, 25.7%; sensitivity and soreness, 4.3%). However, most participants who reported sensitivity alone had undergone VTB (12, 66.7%). Dentin hypersensitivity and, sometimes, mild-to-moderate pain are known complications of tooth bleaching [20]. In this study, almost half (43.5%) of the participants treated with the VTB (nightguard bleaching) technique reported hypersensitivity two weeks after treatment initiation. This eventually diminished and was completely absent at the eight-week follow-up appointment. Gingival soreness was also infrequently reported in this group. This outcome may have been related to the use of customized BTs, which minimized bruising that could result from ill-fitting BTs [21].

Participants treated with composite veneers, on the other hand, reported very few cases (1.4%) of dentin hypersensitivity at both two and eight weeks after treatment. Dentin hypersensitivity has been reported following composite restoration in some individuals, potentially because of overetching and microleakage at the dentin-composite interface [21].

In this study, all three major treatment groups demonstrated substantial observed reductions in OHIP-Aesthetics scores at both follow-up assessments. The overall mean score decreased from baseline to two weeks in the VTB, NVB, and DCV groups, with further reductions observed at eight weeks. Because lower OHIP-Aesthetics scores represent better oral health-related quality of life, these changes are descriptively consistent with improvement following treatment. The magnitude of the observed reduction varied among the treatment groups and across domains.

Participants treated with VTB showed an increase in the mean physical pain score from 2.09 at baseline to 2.38 at two weeks. This pattern is consistent with the posttreatment sensitivity observed among participants in this group. By eight weeks, the mean physical pain score had decreased to 1.63. Thus, the descriptive pattern suggests that the early increase in pain-related impact was followed by improvement at the later follow-up assessment.

These findings were similar to those of Maran et al. [22], who reported no statistically significant impact on the physical pain domain among their study participants. Goettems et al. [23] conducted a triple-blind randomized clinical trial on the impact of tooth bleaching on quality of life in 130 participants. They concluded that participants reported improvements in dental appearance and a positive impact on overall quality of life. Similarly, Bruhn et al. [24] reported improved quality of life among adults aged 50 years and older after tooth whitening. Maran et al. [22] also reported similar psychosocial improvements in their review of nine randomized clinical trials.

In contrast, participants treated with NVB showed substantial observed reductions in all OHIP-Aesthetics domain scores and overall mean scores at two weeks after treatment, except in the physical pain, psychological disability, and social disability domains. These findings were similar to those reported by Goettems et al. [23]. This may be because most participants in this group had only one or a few devitalized, discolored teeth, and the walking bleach technique improved tooth color gradually. Consequently, the improvement in tooth color may not have produced the same degree of immediate perceived change as other methods, particularly DCV. This may mean that more time was required for the psychological impact of having a new and improved smile to become apparent. However, general improvements in quality of life were observed across all domains at eight weeks, as reflected by substantial reductions in the mean domain and overall scores. It is also important to emphasize that the number of participants in this group was small, limiting the statistical power and interpretation of the observed outcomes. Bersezio et al. [25] reported similar findings regarding the effectiveness of NVB on quality of life, describing sustained improvements in tooth color and quality of life six months after treatment.

Furthermore, participants treated with composite veneers reported substantial improvements in quality of life across all domains at both two and eight weeks after treatment. This improvement was demonstrated by continuous reductions in the mean scores for all domains and the overall OHIP-Aesthetics score. Similar studies by Nalbandian and Miller [26], Hamzeh et al. [27], and Harshita et al. [28] reported improvements in psychosocial outcomes and overall quality of life among study participants, including at six-month follow-up visits. DCV can produce an immediate improvement in tooth color, which may explain the substantial improvement in OHIP-Aesthetics scores observed in this study at both follow-up visits. This may lead to an early improvement in perceived smile attractiveness and subsequent improvements in self-esteem and confidence. Moreover, the incidence of posttreatment dentin hypersensitivity was notably low (14.3%) in this study population.

Limitations

There was an uneven distribution of participants across the different treatment categories, which may have introduced bias in comparisons involving groups of different sizes. Additionally, because multiple paired t-tests were performed in this study without statistical correction of p-values, the risk of type I error is acknowledged. Therefore, the observed differences between the pre- and posttreatment mean OHIP-Aesthetics scores ± SEM were used descriptively. An a posteriori consideration of the study also indicates that it was not powered for between-group comparisons, particularly for the NVB group, which included only eight participants. Furthermore, the authors acknowledge that potential confounding factors, including differences in baseline pathologies, may have influenced the outcomes; thus, the observed changes may not be attributable solely to the treatments used. This prospective, nonrandomized interventional (quasi-experimental before-and-after) study was not registered in a prospective trial registry.

Recommendations

A similar prospective, randomized interventional study with an adequate sample size and participants with comparable baseline characteristics and etiologies, randomly allocated in equal numbers to the three major treatment groups, is recommended. This would improve the homogeneity of the dataset and allow appropriate between-group comparisons of the treatment methods. Furthermore, the study duration should be extended to six to 12 months to allow long-term assessment of treatment outcomes. Additionally, assessment of the degree of shade improvement achievable with the different treatment methods is recommended.

Conclusions

The three major restorative treatment methods assessed in this study, such as VTB, NVB, and DCV, were associated with improvements in oral health-related quality of life at two and eight weeks after treatment. These improvements were reflected in substantial observed reductions in OHIP-Aesthetics scores during this period. However, because the participant-level OHIP-Aesthetics data required for appropriate retrospective nonparametric testing were unavailable, the observed changes should be interpreted as descriptive rather than as definitive evidence of statistically significant treatment effects. Future prospective studies with larger and more evenly distributed treatment groups, standardized baseline characteristics, and retention of participant-level outcome data are recommended.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

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