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Postoperativna preosjetljivost nakon uporabe dvaju sredstava za profesionalno izbjeljivanje zuba

Postoperative Sensitivity after Two in-Office Bleaching Methods

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Sažetak
Svrha: Željelo se odrediti stupanj postoperativne preosjetljivosti nakon uporabe dvaju sredstava za profesionalno izbjeljivanje vitalnih zuba. **Materijal i postupci:** Istraživanje je provedeno na 22 ispitanika podijeljena u dvije skupine (po 11 sudionika) koji su dobrovoljno pristali na postupak izbjeljivanja zuba. Koristili smo se dvama preparatima za profesionalno izbjeljivanje – 25-postotnim vodikovim peroksidom Zoom 2 uz svjetlosnu aktivaciju izvorom svjetlosti te 38-postotnim vodikovim peroksidom Opalescence Boost bez aktivacijskog učinka izvora svjetlosti. Preosjetljivost se ocjenjivala na vizualno analognoj ljestvici (VAS-u) odmah nakon postupka, te 6 i 24 sata poslije izbjeljivanja. **Rezultati:** Rezultati su analizirani testom Wilcoxon Rank Sum. Razlika između postoperativne preosjetljivosti kod izbjeljivanja preparatima Zoom 2 i Boost, izmjerena odmah te 6 i 24 sata poslije izbjeljivanja, nije bila statistički značajna ($p>0,05$). Kod oba preparata postoperativna preosjetljivost bila je najizraženija odmah nakon postupka te 6 sati poslije izbjeljivanja ($p<0,05$). Dakle, ispitanici su pokazali jasnu pojavu postoperativne preosjetljivosti, no smanjivala se prema vrijednostima izmjerenima 24 sata poslije zahvata. **Zaključak:** Postoperativna bol i preosjetljivost tijekom obaju postupaka izbjeljivanja s različitim koncentracijama vodikova peroksida te nakon njih, moguće su nuspojave koje su najizraženije odmah nakon postupka te poslije šest sati, smanjujući se prema vrijednostima izmjerenima 24 sata nakon izbjeljivanja.

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Uvod

U literaturi su opisani mnogi postupci poboljšavanja estetike zuba. Najkonzervativniji je promjena boje i izbjeljivanje. Najčešći su postupci izbjeljivanja profesionalno izbjeljivanje pod kontrolom stomatologa (*in – office bleaching, power bleaching*) i izbjeljivanje kod kuće (*at home bleaching*). U prvom postupku koristimo se visokom koncentracijom sredstva za izbjeljivanje koje se nanosi na zube nakon što se zaštite mekana tkiva. Za postupak izbjeljivanja kod kuće upotrebljavaju se niske koncentracije sredstva za izbjeljivanje, a unosi se u individualno pripremljene udlage (1). Postupci izbjeljivanja vitalnih zuba temelje se na uporabi vodikova peroksida ili karbamidnog peroksida. U doticaju s vodom karbamidni peroksid razlaže se na ureu i vodikov peroksid. Desetpostotni karbamidni peroksid tako otpušta 3,6 posto vodikova peroksida (2). Vodikov peroksid jako je nestabilan i disocira otpuštajući slobodne kisikove radikale, a urea se razlaže na amonijak i ugljični dioksid (3). Mehanizam djelovanja vodikova peroksida nije u cijelosti razjašnjen, ali smatra se da je za

Introduction

A number of methods have been described in literature to improve esthetic appearance of teeth. The most conservative procedure to change tooth color is the bleaching procedure. The frequently used bleaching techniques are *in-office* bleaching and *at home* bleaching. The first method uses a high concentration of bleaching agent. The whitening gel is applied to the teeth after protecting the soft tissues. For home bleaching, low levels of whitening agent are dispersed in a custom-made mouth guard (1). All tooth bleaching procedures are based on either hydrogen peroxide or carbamide peroxide as the whitening agent. When carbamide peroxide comes into contact with water, it breaks down into urea and hydrogen peroxide. Ten percent carbamide peroxide releases a maximum of 3.6 % hydrogen peroxide (2). Hydrogen peroxide, the active bleaching agent, is very unstable and easy to dissociate, resulting in the release of free oxygen radicals, while urea decomposes to ammonia and carbon dioxide (3). Although the action mechanism of hydrogen peroxide is not

izbjeljivanje odgovoran proces oksidacije u kojemu se velike pigmentirane molekule razlažu na manje (1,4,5).

Bol je, prema International Association for the Study of Pain (1979., p. 250), definirana kao neugodan osjećaj i emocionalan doživljaj povezan sa stvarnim ili potencijalnim oštećenjem tkiva (6). S obzirom na to da je bol definirana kao ''doživljaj", obično se ocjenjuje na temelju informacija dobivenih od pacijenta ili subjekta izloženog bolnim eksperimentalnim stimulansima. Tako se procjena boli temelji isključivo na subjektivnom doživljaju (7). Vizualno analogna ljestvica (VAS) često se rabi kao instrument za procjenu boli te je preuzela prednost mnogim drugim ljestvicama (8).

Većina ljudi vrlo dobro podnosi izbjeljivanje zuba. Preosjetljivost se povezuje s pojavom mikroskopskih caklinskih defekata i potpovršinskih pora s mogućim prodorom sredstva za izbjeljivanje do pulpe. Ipak, preosjetljivost povezana s izbjeljivanjem zuba može se kod nekih pacijenata pojaviti kao problem. Schulte i suradnici otkrili su da je kod 14 posto pacijenata ta preosjetljivost bila toliko jaka da se morao prekinuti postupak izbjeljivanja (9). Leonard i njegovi kolege dokazali su da mnoga predoperativna stanja mogu potaknuti preosjetljivost tijekom izbjeljivanja i nakon njega. Jedna od njih je dentinska preosjetljivost prije početka izbjeljivanja (10). Iritacija desni i mekanih tkiva također je česta, ali prolazna popratna pojava. Javlja se ako se rabi veća količina i jača koncentracija sredstava za izbjeljivanje te u slučaju dugotrajne primjene preparata kod kuće. Pojave li se iritacije, izbjeljivanje treba prekinuti. Kako bi se izbjegla nadraženost preporučuje se koristiti se manjom količinom gela, gelom s manjom koncentracijom vodikova peroksida, izbjegavati kontakt s gingivom, što se postiže pažljivim postavljanjem izolacije, zatim dati izraditi individualnu udlage te je kraće nositi (11).

Učinak na zubnu pulpu očituje se kao bolna senzacija i preosjetljivost tijekom izbjeljivanja i nakon toga postupka. I bol i preosjetljivost objašnjavaju se iritirajućim djelovanjem vodikova peroksida na stanice zubne pulpe jer molekula H_2O_2, zbog male molekulske mase, može difundirati kroz sloj cakline i dentina sve do pulpe. Tamo uzrokuje blagi reverzibilni pulpitis (12), što se manifestira kao preosjetljivost i intermitentna spontana bol. Incidencija preosjetljivosti i boli ovisi o koncentraciji primijenjenog preparata, odnosno o vrsti izbjeljivanja te je veća kod postupka „*power bleaching*" – iznosi između 67 i 78 posto (13). Histološki se u pulpi, kao odgovor na iritaciju, vidi slaba upalna reakcija, promijenjena morfologija odontoblasta i pojačana dentinogeneza (14). Ta popratna pojava je prolazna i nestaje najkasnije četvrti dan nakon tretmana (9).

Svrha rada bila je procijeniti razliku u postoperativnoj preosjetljivosti nakon uporabe sredstava za izbjeljivanje različitih koncentracija ili uporabe svjetlosti, ali i jakost i trajanje preosjetljivosti nakon jednokratnog izbjeljivanja zuba. Preosjetljivost se mjerila prije postupka, odmah nakon njega te 6 i 24 sata poslije vanjskog (vitalnog) izbjeljivanja 25-postotnim i 38-postotnim vodikovim peroksidom.

Nulta hipoteza bila je da nema razlike s obzirom na stupanj preosjetljivosti prije postupka, odmah nakon njega te 6 i 24 sata poslije izbjeljivanja, odnosno da između korištenih

well understood, it is considered to be an oxidation reaction, where the pigmented molecules are broken down and the small compounds diffuse out of the tooth (1, 4, 5).

The pain is defined by the International Association for the Study of Pain (1979, p. 250) as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (6). Because pain is defined as "an experience", it is usually assessed by eliciting information directly from the patient in clinical settings or from the subject exposed to a painful experimental stimulus in the laboratory; that is, pain is generally assessed through "subjective" self-report measures (7). The visual analogue scale (VAS) is frequently used in research settings for assessment of pain and it overcomes some of the shortcomings of categorical scales (8).

Most people usually tolerate tooth whitening very well. However, postoperative sensitivity can occur in some cases and can cause problems in those patients. The sensitivity caused by tooth whitening is usually related to the small microscopic enamel defects and subsurface pores, and the ability of whitening agent to penetrate to the pulp. Schulte et al. found that sensitivity was severe enough to cause 14% of patients to discontinue bleaching (9). Leonard and colleagues noted that many preoperative conditions can cause pain during and after the whitening treatment. One of them is the presence of dentin hypersensitivity before whitening treatment (10). Gingival and soft tissue irritation is also a common, but temporary side effect. It is usually related to high concentrations of whitening agents or to long term *at home* usage. If the irritation occurs, the whitening procedure should be cancelled. To avoid this irritation, a smaller amount of whitening agent with lower concentrations should be used. To avoid contact with soft tissue, gingiva should be isolated or individual tray should be made for each patient (11).

The effect on human pulp manifests as pain sensation and sensitivity during and after the treatment. Pain and sensitivity can be explained by irritating effect of hydrogen peroxide on the pulp cells because the molecules of hydrogen peroxide can, because of their small molecular mass, penetrate to the pulp through enamel and dentin. There, they can cause mild reversible pulpitis (12), which can be manifested as tooth hypersensitivity and intermittent spontaneous pain. The incidence of pain and sensitivity depends on the concentration of bleaching agent and also on the type of bleaching and is usually higher during power bleaching where the concentration is usually about 67-78% (13). Histologically, there is a mild inflammation process within the pulp, with visible changes in odontoblast morphology and reinforced dentinogenesis as a response to irritation (14). This side effect is temporary and it disappears at least four days after the treatment (9).

The aim of this study was to assess the magnitude and the duration of sensitivity following a single visit bleaching treatment rather than evaluating the differences in postoperative sensitivity made by different concentrations of bleaching agents or by the activation by light. The aim of this study was to measure and evaluate the level of sensitivity before

sustava i između spolova nema razlike u pojavnosti postoperativne preosjetljivosti.

Ispitanici i postupci

Istraživanje je provedeno na 22 dobrovoljna ispitanika (11 muškaraca i 11 žena). Nasumce su raspoređeni u dvije skupine po 11 sudionika, ovisno o preparatu kojim smo se koristili za izbjeljivanje zuba. Skupinu "Zoom 2" činila su šestorica muškaraca i pet žena, a u skupini "Boost" bila su četvorica muškaraca i sedam žena. Jedan je ispitanik isključen zbog iznimne preosjetljivosti već na početku tretmana preparatom Boost.

Prema prije određenim kriterijima ispitanici odabrani za ovu studiju bili su u dobi između 18 i 28 godina, s dobrom oralnom higijenom, bez bolesti parodonta i gingivitisa, sa zdravim zubima bez karijesa te bez velikih restoracija i cerviksnih lezija. Svi su bili nepušači. Iz studije su bile isključene trudnice i dojilje, pacijenti s jakim obojenjima zuba (tetraciklinska obojenja, flouroza, endodontski zahvati) i oni s već provedenim tretmanom izbjeljivanja. Svi su prije istraživanja potpisali informirani pristanak koji je odobrilo Etičko povjerenstvo Stomatološkog fakulteta Sveučilišta u Zagrebu. Postupci izbjeljivanja obavljali su se ujutro u Zavodu za endodonciju i restaurativnu stomatologiju Stomatološkog fakulteta.

Prije postupka ispitanicima su uklonjene tvrde i meke zubne naslage zvučnim uređajem za uklanjanje tvrdih zubnih naslaga SONICflex (Dentsply, Mildford, SAD) te naknadnim poliranjem profilaktičnom pastom Proxyt (Ivoclar Vivadent, Schaan, Lichtenstein). Početna nijansa zuba određivala se prema "ključu boja" (Vita shade guide, Vita Zahnfabrik, Bad Säckingen, Njemačka). U studiju su bili uključeni samo ispitanici čija je početna boja bila barem dvije nijanse tamnija od najsvjetlije nijanse iste boje. Postupak izbjeljivanja obavljao se prema tvorničkim standardima i uputama i rabila su se dva preparata na bazi vodikova peroksida. Prvi je bio 25-postotni vodikov peroksid tvorničkog imena Zoom 2 (Discus Dental, Culver City, SAD) uz svjetlosnu aktivaciju izvorom svjetlosti Zoom 2 istoga proizvođača. Drugi je preparat bio 38-postotni vodikov peroksid tvorničkog naziva Opalescence Boost (Ultradent Products, South Jordan, SAD) bez aktivacijskog učinka izvora svjetlosti. Za svaki se morao postaviti retraktor i obaviti pretpriprema oralne sluznice zaštitnim gelom Liquidam (Discus Dental, Culver City, SAD) i Opaldam (Ultradent Products, South Jordan, SAD) kako bi se spriječio kontakt materijala za izbjeljivanje sa sluznicom usne šupljine. Na labijalne plohe zuba od 14. do 24. te 34 i 44 nanesen je sloj gela debljine jedan do dva milimetra kistom iz originalnog pakiranja. U skupini u kojoj je izbjeljivanje provedeno preparatom Zoom 2 zubi su bili 15 minuta

and immediately after, as well as 6 and 24 hours after external (vital) whitening treatment with 25% and 38% of hydrogen peroxide gel.

Null hypothesis: there is no difference in sensitivity before and immediately after the treatment, as well as 6 and 24 hours after each whitening treatment. There is no difference between the two whitening systems used in this study and there is no difference in postoperative sensitivity between the genders.

Materials and methods

Twenty-two patients took part in this study and they voluntarily agreed to a bleaching treatment. They were randomly divided into two groups of 11 people, based on the bleaching agent used. Six males and five females participated in the Zoom2 group and four males and seven females participated in the Boost group. One patient was excluded from the study because of the hypersensitivity occurring during the first few minutes of Boost whitening treatment.

Based on the pre-established criteria, patients selected for this study were as follows: between the ages of 18-28 years, had good oral hygiene, were free of periodontal disease and gingival irritation, had healthy teeth without major restorations and were free of cervical lesions. All patients were non-smokers. Patients were excluded from the study if they: were pregnant or nursing, had severely stained teeth (tetracycline stains, fluorosis, endodontic treatment) and had previously undergone tooth whitening procedures. The institutional Ethics Committee was notified, and patients had given their informed consent to their participation in the study. All the bleaching treatments were performed in the morning at the Department of Endodontics and Restorative Dentistry School of Dental Medicine.

Before the bleaching treatment, calculus and stains were removed using a sonic instrument SONICflex (Dentsply, USA) and followed by polishing the teeth with prophylactic paste Proxyt (Ivoclar Vivadent, Schaan, Liechtenstein). The primary shade of participant's teeth was determined employing a visual shade matching system (Vita shade guide, Vita Zahnfabrik, Bad Säckingen, Germany). Only the patients who had their primary teeth color two times darker than the lightest shade of the same color took part in this study.

The bleaching procedure was conducted according to the manufacturer's instructions and two bleaching agents based on hydrogen peroxide were used. One of them was based on 25% hydrogen peroxide named Zoom2 (Discus Dental, Culver City, USA) and was initialized by light source of the same manufacturer. Another one was based on 38% hydrogen peroxide named Opalescence Boost (Ultradent products, South Jordan, USA) without the light initiation. Both of them required preparation of the patients' soft tissue with protective gel Liquidam (Discus Dental, Culver City USA) and Opaldam (Ultradent products, South Jordan, USA) so the contact between the bleaching agent and patients soft tissue can be avoided. Labial surfaces of the teeth 14-24 and 34-44 were then covered with whitening agent gel in about 1-2 mm thick layer using the original manufacturer brush.

osvijetljeni izvorom svjetlosti. U skupini u kojoj je izbjeljivanje obavljeno preparatom Boost, gel je bez osvjetljavanja bio postavljen 15 minuta. Zatim je ispitanicima iz obiju skupina gel uklonjen Heidemannovim instrumentom 5/6 i svitcima staničevine. Postupak nanošenja gela ponovljen je tri puta i svaki je put trajao 15 minuta. Nakon izbjeljivanja, uklonjeni su zaštitni gel i retraktor, a usta su isprana vodom.

Prije izbjeljivanja ispitanici su se izjasnili u vezi s mogućom predoperativnom preosjetljivošću i to tako da su odgovorili na pitanje je li ona bila: 0 – nepostojeća, 1 – blaga, 2 – umjerena i 3 – jaka. Preosjetljivost je ocijenjena uz pomoć stimulansa stlačenoga zraka iz zračne mlaznice koju je ispitivač jednu sekundu usmjerio u područje zubnog vrata, držeći je na udaljenosti od dva do tri milimetra. Svi ispitanici istaknuli su vrijednost 0, dakle prethodne preosjetljivosti nije bilo. Subjektivni osjećaj boli tijekom postupka izbjeljivanja te nakon 6 i 24 sata, zabilježen je VAS-om. To je 100-milimetarska ljestvica koja predstavlja kontinuitet boli i ograničena je na jednom kraju oznakom ''bez boli", a na drugom kraju oznakom ''najveća moguća bol". Ispitanik stavlja oznaku koja odgovara jakosti doživljene boli i zatim se mjeri udaljenost u milimetrima od oznake ''bez boli" do oznake boli pojedinog pacijenta. Prema VAS-u bol je ocijenjena kao: bez boli (0–9 milimetara), mala bol (10–40 milimetara), umjerena (41–70 milimetara) i jaka (71–100 milimatara). Nakon svakog novog mjerenja, ispitanik se koristio novom vizualno analognom ljestvicom boli kako ne bi bio pod utjecajem već zabilježenih rezultata.

Statistička analiza

Podaci su analizirani mjerenjem udaljenosti od lijeve krajnje oznake na VAS-u do oznake koja odgovara opisanoj boli (mm). Izračunate su srednje vrijednosti i standardne devijacije stupnja preosjetljivosti za svaku skupinu i to odmah nakon postupka izbjeljivanja te 6 i 24 sata poslije. Budući da podaci nisu bili normalno distribuirani, za usporedbu srednjih vrijednosti koristili smo se neparametrijskim testom Wilcoxon Signed Rank uz razinu značajnosti 0,05, za što se rabio program SAS 8,2 (SAS Institute Inc, Sjeverna Carolina, SAD).

Rezultati

Vrijednosti dobivene mjerenjem preosjetljivosti odmah nakon postupka, te 6 i 24 sata poslije njega, prikazane su u tablicama i grafikonima. Tablica 1. i slika 1. predstavljaju rezultate dobivene uporabom preparata Zoom 2. Na tablici 2. i slici 2. su rezultati dobiveni uporabom preparata Boost. Razlike između parova grupa, odnosno između skupina kod izbjeljivanja preparatom Zoom 2 (odmah nakon postupka i šest sati poslije), (odmah nakon postupka i 24 sata poslije) te (nakon 6 sati i poslije 24 sata) analizirane su testom Wilcoxon Signed Rank. Uočena je statistički visoko značajna razlika između skupina (odmah nakon postupka i poslije 24 sata – p=0,001) i (nakon 6 sati i poslije 24 sata – p=0,002). Između skupina (odmah nakon postupka i poslije 6 sati) nije uočena statistički značajna razlika (p=0,72). Istim testom analizirane su razlike između parova skupina, odnosno izme-

In the Zoom2 group, teeth were irradiated with light source for 15 minutes. In the Boost group, the gel was left for 15 minutes without the light source. After each bleaching treatment, the gel was removed by Heidemann instrument and a cotton pellet. This treatment was repeated three times for 15 minutes each. After the entire treatment was finished, the whitening gel, soft tissue protective gel and lip and tongue retractor were removed and patients' mouths were rinsed with water.

Before the treatment, patients replied about their possible preoperative tooth sensitivity by answering the question if the sensitivity was: 0- none, 1-slight, 2-moderate, 3-severe. The degree of sensitivity was verified with a light air jet over the labial surface of the teeth in the root region during 1 second and at the distance of 2-3 mm. All patients had 0 degree of sensitivity, which meant that there was no preoperative sensitivity. The subjective intensities of sensitivity immediately after the treatment, and 6 and 24 hours later were measured using VAS. The VAS consisted of a 100-mm line, which represents a continuum of pain and it is anchored at each end with terms describing the amount of pain felt from "no pain" to "worst pain possible". The subjects made a mark on the line corresponding to the amount of pain felt, and the distance from the "no pain" end of the scale to this mark was measured in mm. According to the VAS the pain was rated as: none (0- 9 mm), slight pain (10-40 mm), moderate (41-70mm), and severe (71-100 mm). After each treatment, patients used the new VAS so that they could not be influenced by the previous result.

Data analysis

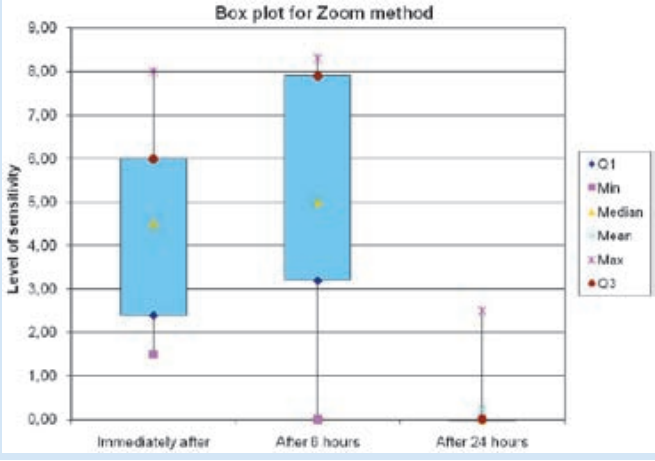
Data were analyzed by measuring the distance between the left extreme of the VAS and the mark corresponding to each pain descriptor (mm). Mean values and standard deviations for each group, immediately after and 6 and 24 hours after the treatment, were calculated. Data were not normally distributed and for comparison of mean values non- parametric Wilcoxon Signed Rank Test with the significance level of 0.05 was used. SAS 8.2 (SAS Institute Inc, North Carolina, USA) was used for data analysis.

Results

Postoperative sensitivity data measured immediately, and 6 and 24 hours after the treatment were shown in tables and figures. Table 1 and Figure 1 show the results after bleaching with Zoom2. Table 2 and Figure 2 show the results after bleaching with Boost. Differences between groups and group pairs in Zoom2 group (immediately after – after 6 hours), (immediately after - 24 hours after) and (after 6 hours – after 24 hours) were analyzed by Wilcoxon Signed Rank Test. A statistically significant difference was found between the groups (immediately after – after 24 hours p=0.001) and between (after 6 hours - after 24 hours p=0.002). No statistical difference was found (p=0.72) between the 'immediately after – 6 hours after groups'. Differences between groups and group pairs in Boost group (immediately after –after 6 hours), (immediately after - 24 hours after) and (after 6

Tablica 1. Vrijednosti aritmetičke sredine, koeficijenta varijacije, medijana i standardne devijacije kod primjene preparata Zoom 2. * Zbog velikih koeficijenta varijacije (>30 %) kao reprezentativna srednja vrijednost prikazani su medijani.
Table 1 Arithmetic mean, coefficient of variation, median and standard deviation when using Zoom2. * Because of the great coefficient of variation (> 30%) medians are shown as representative mean value.

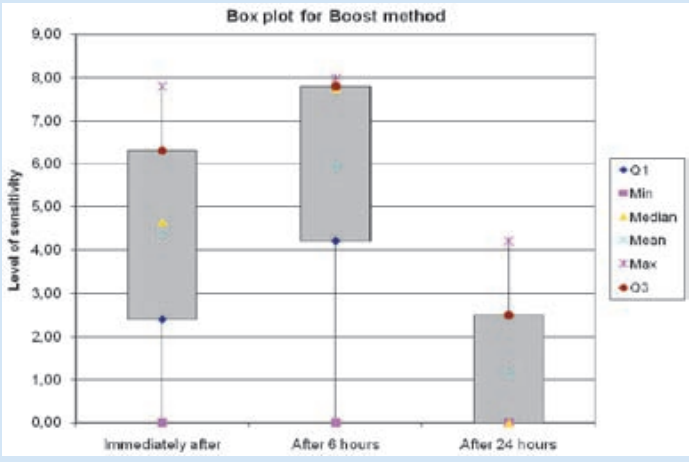
Postoperativna bol • Postoperative pain	Broj ispitanika • Number of patients	Aritmetička sredina • Arithmetic mean	Koeficijent varijacije (%) • Coefficient of variation (%)	Medijan • Median	Standardna devijacija • Standard deviation
Odmah nakon izbjeljivanja • Immediately after bleaching	11	4.47	43.43	4.50	1.94273
Nakon 6 sati • After 6 hours	11	5.03	51.67	5.00	2.59734
Nakon 24 sata • After 24 hours	11	0.23	331.66	0.00	0.75378



Slika 1. Raspon intenziteta postoperativne preosjetljivosti kod izbjeljivanja preparatom Zoom 2
Figure 1 Range of postoperative sensitivity intensity after Zoom2 bleaching treatment.

Tablica 2. Vrijednosti aritmetičke sredine, koeficijenta varijacije, medijana i standardne devijacije kod primjene preparata Boost. * Zbog velikih koeficijenta varijacije (> 30 %) kao reprezentativna srednja vrijednost prikazani su medijani.
Table 2 Arithmetic mean, coefficient of variation, median and standard deviation when using Boost. * Because of the great coefficient of variation (> 30%) medians are shown as representative mean value.

Postoperativna bol • Postoperative pain	Broj ispitanika • Number of patients	Aritmetička sredina • Arithmetic mean	Koeficijent varijacije (%) • Coefficient of variation (%)	Medijan • Median	Standardna devijacija • Standard deviation
Odmah nakon izbjeljivanja • Immediately after bleaching	10	4.38	57.05	4.65	2.49880
Nakon 6 sati • After 6 hours	10	5.93	48.45	7.75	2.87288
Nakon 24 sata • After 24 hours	10	1.15	136.59	0.00	1.57074



Slika 2. Raspon intenziteta postoperativne boli kod izbjeljivanja Boostom
Figure 2 Range of postoperative sensitivity intensity after Boost bleaching treatment.

đu skupina kod izbjeljivanja Boostom (odmah nakon postupka i poslije 6 sati), (odmah nakon postupka i poslije 24 sata) (nakon 6 sati i poslije 24 sata). Uočena je statistički značajna razlika između skupina (odmah nakon postupka i poslije 24 sata – p=0,01) i (nakon 6 sati i poslije 24 sata – p=0,004). Između skupina (odmah nakon postupka i poslije 6 sati) nije uočena statistički značajna razlika (p=0,12).

Također se analizirala razlika između modela Zoom 2 i Boost, odnosno testirana je nulta hipoteza da su distribucije vjerojatnosti obiju populacija jednake u svakoj vremenskoj točki mjerenja (uspoređivani su parovi grupa koje se odnose na istu vremensku točku mjerenja između dviju skupina – Zoom2 i Boost). Koristili smo se testom Wilcoxon Rank Sum. Nisu uočene statistički značajne razlike u distribuciji između dvaju modela (p>0,05). Razlike u distribucijama rezultata preosjetljivosti odmah nakon postupka te poslije 6 sati i 24 sata između žena i muškaraca testirane su posebno za postupak izbjeljivanja Zoomom 2, odnosno Boostom. Nisu pronađene statistički značajne razlike u distribuciji tih rezultata između žena i muškaraca (p>0,05).

Rasprava

U ovom istraživanju nastojali smo uz pomoć VAS-a prikazati kako se i kojim intenzitetom mijenja stupanj boli, ovisno o postupku izbjeljivanja. Ta se ljestvica pokazala jednostavnom za uporabu, pouzdana je i vjerodostojna, a koristi se u mnogim područjima dentalne medicine za procjenu boli, primjerice kod dentinske preosjetljivosti, nakon parodontoloških ili kirurških zahvata te uobičajene postoperativne preosjetljivosti (15–23). Unatoč korištenju VAS-a teško je usporediti bol nastalu kod ostalih stomatoloških zahvata s onom nakon izbjeljivanja jer je ona uzrokovana termičkim, osmotskim ili mehaničkim stimulansima dovedenima u kontakt s dentinom. Bol i stupanj nelagode teško je, pa gotovo i nemoguće, objektivizirati zbog složenih psihičkih i fizičkih aspekata (24). Prava priroda doživljaja boli nije dostupna ispitivaču te se zato on mora oslanjati na pacijentovu mogućnost percepcije i interpretacije boli. U mnogim kliničkim istraživanjima rabio se jedan od oblika VAS-a za mjerenje određenih vrsta i jakosti boli. Taj se postupak pokazao pouzdanim u mjerenjima promjena boli u određenom vremenskom razdoblju, ali s obzirom na bilježenje subjektivne tj. psiho-sociološke komponente boli, nije moguća jednostavna usporedba između populacija i vrsta bolesti (25).

Razlika između postoperativne boli i preosjetljivosti kod sredstava za izbjeljivanje Boost i Zoom 2, izmjerena u sva tri vremenska razdoblja, nije bila statistički značajna (p>0,05). Oba sredstava imala su jednaku prevalenciju postoperativne boli koja je bila najveća neposredno nakon postupka i poslije 6 sati, a smanjivala se prema vrijednostima izmjerenima 24 sata poslije koje su statistički bile jednake vrijednostima prije tretmana. Tavares i suradnici opisali su bol nakon izbjeljivanja s 15-postotnim vodikovim peroksidom (VP-om) i

hours – after 24 hours) were analyzed by Wilcoxon Signed Rank Test. A statistically significant difference was found between groups (immediately after – 24 after hours, p=0.01) and between (after 6 hours - after 24 hours, p=0.004). No statistical difference was found (p= 0.12) between 'immediately after – 6 hours after' groups.

The difference between Zoom2 and Boost models was analyzed with reference to null-hypothesis in which the value distributions of both populations were measured at the same time sequence. We compared the group pairs which were related to same measuring time sequence between Zoom2 and Boost population. Data were analyzed by Wilcoxon Signed Rank Test. No statistically significant difference was found between these two models (p>0.05). The difference between the related distributions immediately, and 6 and 24 hours after the treatment were tested both for male and female population while using Zoom2 and Boost bleaching method. Data were analyzed by Wilcoxon Signed Rank Test. No statistically significant difference was found between the males and females in both the Zoom2 and the Boost bleaching groups (p>0.05). Our results showed that postoperative pain immediately after and 6 hours after the treatment was moderate and severe, and 24 hours after the treatment was absent, or in some cases slight.

Discussion

The aim of this study was to study the changes of the extent and the intensity of postoperative pain following the whitening treatment. For that purpose, we have used the VAS, which was shown to be simple to use, reliable and valid and it has been used in many fields of dental medicine for assessment of dental pain, such as dentin hypersensitivity during different periodontal treatments, surgical procedures or baseline preoperative hypersensitivity (15-23). Even by using VAS as a measurement it can be difficult to compare pain scores and values measured in other dental areas with those caused by bleaching because hypersensitivity can be induced by thermal, osmotic, or mechanical stimuli brought into contact with sensitive dentin. Measurement of pain and discomfort is inherently difficult, since it has both physical and psychological aspects (24). Subjectively, the true character of pain experience is not directly accessible to the examiner. Therefore, the examiner must rely on the patient's ability to communicate his or her perception and interpretation of pain. Nonetheless, many clinical investigators have used several modifications of the VAS to generate a quantitative measure of pain. This method appears to be reliable in tracking changes in pain over time in the same subject, but given the evidence regarding the subjective (psychosocial) component to the rating of pain; it does not permit any comparisons of pain experienced between populations and different types of diseases (25).

The difference between postoperative pain and sensitivity between Boost and Zoom2 whitening agents measured in all three time periods was not statistically significant (p>0.05). Both whitening treatments show the same prevalence of postoperative pain which was the greatest immediately after and

učinkom svjetlosti i bez nje. Izbjeljivanje VP-om uz uporabu svjetlosti i VP-om bez svjetlosti pokazalo je veću preosjetljivost, negoli samostalna uporaba svjetlosti bez VP-a (26). Ti rezultati jasno povezuju pojavu preosjetljivosti s uporabom VP-a, a ne s uporabom svjetlosti. Usporedbom navedenog nalaza i našeg istraživanja potvrdili smo da je umjerena i jaka preosjetljivost postojala odmah nakon izbjeljivanja. Alomari i njegovi kolege pokazali su da je neposredna postoperativna preosjetljivost najmanja kada se upotrebljava samo 35-postotni VP bez svjetlosne aktivacije, a najveća je zabilježena za 35-postotni VP uz svjetlosnu aktivaciju izvorom svjetlosti BriteSmile i plavim polimerizacijskim svjetlom. Postoperativna preosjetljivost u skupini s 35-postotnim VP-om i Zoomom 2 osvjetljavanja metal halogenom svjetiljkom nije bila statistički značajna (27). Svjetiljka Zoom 2, kojom smo se koristili u našem istraživanju, također nije utjecala na pojačavanje postoperativne preosjetljivosti. Bernardon i suradnici mjerili su VAS-om preosjetljivost zuba 15 dana. Profesionalno izbjeljivanje s 35-postotnim VP-om, samostalno i uz svjetlosnu aktivaciju, pokazalo je veću pojavnost postoperativne preosjetljivosti nego uporaba 10-postotnog karbamidnog peroksida za izbjeljivanje kod kuće (28). U ovom istraživanju nismo se koristili sredstvima za izbjeljivanje zuba kod kuće, ali dokazali smo da visoke koncentracije vodikova peroksida korištenog za profesionalno izbjeljivanje mogu uzrokovati prolaznu postoperativnu preosjetljivost. Kugel i suradnici procijenili su profesionalnu uporabu gela 25-postotnog vodikova peroksida uz svjetlosnu aktivaciju (Discus Dental, Zoom), zatim gel samostalno i svjetlost bez djelovanja peroksida. U skupini "gel + svjetlo" , 91 posto ispitanika osjetilo je preosjetljivost uglavnom umjerenu ili jaku, kao i onu koja je zabilježena u našem istraživanju (29). Amengual i Forner opisali su preosjetljivosti nakon izbjeljivanja različitim sredstvima temeljenima na vodikovu i karbamidnom peroksidu koji se upotrebljavaju za profesionalno i izbjeljivanje kod kuće. Najveća preosjetljivost zabilježena je kod korištenja kemijski aktiviranog 35-postotnog VP-a (70 %) i svjetlosno aktiviranog 35-postotnog VP-a (100 %) (30). Materijali kojima smo se koristili u našem istraživanju nisu bili jednake koncentracije kao oni u navedenom istraživanju, ali su također sadržavali visoke koncentracije VP-a. Jedan od njih bio je kemijski aktiviran (Boost), a drugi je bio svjetlosno aktiviran (Zoom 2) i za oba su ispitanici istaknuli prolaznu umjerenu i jaku postoperativnu preosjetljivost.

Uzrok dentinske preosjetljivosti nije još u cijelosti istražen. Bol je uzrokovana toplinskim, osmotskim ili mehaničkim podražajima koji dolaze u doticaj s dentinom (31). Preosjetljivost kao posljedica izbjeljivanja može se pojaviti i kod ljudi bez eksponiranog dentina i zato se taj fenomen ne može objasniti samo hidrodinamičkom teorijom nastanka preosjetljivosti. Istraživanja u području neuropsiholoških mehanizama preosjetljivosti pokazuju da osjetljivost nastaje kao posljedica upalom induciranih živčanih završetaka na pulpo-dentinskoj granici (32,33). Postupan razvoj upalnog procesa tako objašnjava nastanak odgođene preosjetljivosti kao posljedice izbjeljivanja (34). Subjektivnom osjećaju boli također je svojstveno da mnogobrojni emocionalni doživljaji utječu na njezin intenzitet (35). Anksioznost, strah i depre-

6 hours after the treatment, and decreased to the values measured 24 hours after the treatment, which were statistically equal to the pre-treatment values. Tavares et al. evaluated tooth sensitivity after the bleaching treatment with 15% hydrogen peroxide (HP), with and without light. The responses of the participants indicated that in the peroxide-and-light and peroxide-alone treatment groups, both produced higher incidence of sensitivity than the light-alone treatment group (26). These results clearly associate tooth sensitivity with peroxide rather than light. Comparing the reports of moderate and greatly increased sensitivity to the findings of our study, it can be confirmed that the greatest postoperative sensitivity occurs immediately after the bleaching treatment. In the study by Alomari et al., immediate postoperative sensitivity was the least when using 35% HP without light and the greatest for 35% HP plus BriteSmile and a blue curing light. Postoperative sensitivity in group with 35% HP and a Zoom2 metal halide curing light was not statistically significant (27). Zoom2 light used in our study also showed no impact on the increase of postoperative sensitivity. Bernardon et al. measured tooth sensitivity using a VAS scale for 15 days. *In-office* tooth bleaching with 35% HP with light activation and *in-office* bleaching with 35% HP alone resulted in higher sensitivity rates than *at-home* treatment using only 10% carbamide peroxide (28). We did not use any type of *at-home* bleaching treatment, but our results also showed that high concentrations of hydrogen peroxide used for *in-office* bleaching treatment cause temporary postoperative sensitivity. Kugel at al. evaluated professional application of a 25% hydrogen peroxide gel (Discus Dental Zoom) with light enhancement, gel alone, or the light alone with no peroxide. In the gel + light group, 91% of subjects experienced tooth sensitivity, the majority of which was moderate or severe as found in our study (29). Amengual and Forner reviewed the appearance of post-whitening tooth hypersensitivity in clinical cases treated with different hydrogen and carbamide peroxides used for *in-office* and *at-home* whitening treatments techniques. The greatest sensitivity was observed with *in-office* 35% HP chemically activated (70%) and 35% HP light-activated (100%) whitening techniques (30). Materials used in our study were not of the same concentration as used in that one, but they had high concentrations of HP. One of them was chemically activated (Boost) and another was light activated (Zoom2) and they both showed prevalence of transient moderate and severe postoperative sensitivity.

The cause of tooth hypersensitivity has not yet been evaluated completely. Such pain is induced by thermal, osmotic, or mechanical stimuli brought into contact with the sensitive dentin (31). Hypersensitivity as a result of tooth whitening may also occur despite the lack of dentin exposure, so this phenomenon cannot be ascribed only to a hydrodynamic mechanism. Neurophysiologic mechanisms of hypersensitivity indicate that sensitivity can develop as a result of inflammation-induced sensitization of the nerves in the pulp-dentin border (32, 33). In this context, the gradual development of inflammation could explain bleaching-related sensitivity during the process of whitening, not immediately but after a certain period (34). In addition to the subjectivity inherent in

sija čimbenici su koji mogu utjecati na percepciju boli, kao i pacijentova sposobnost suočavanja s njima (36). Prema istraživanjima Kenta, jako anksiozni pacijenti očekuju više boli nego što je doista dožive, vjerojatno zbog procjene na temelju prijašnjih bolnih iskustava (37). Dworkin i Chen dokazali su da je znatno veća reakcija na bol zabilježena tijekom testiranja vitaliteta pulpe kod pacijenata kojima je postupak obavljen u ambulantnim uvjetima (38). U ostalim se istraživanjima ističe da preplašeni stomatološki pacijenti imaju prag boli i tolerancije prema nestomatološkim stimulansima sličan kao i oni koji nemaju strah od stomatologa, a stimulanse stomatološkog podrijetla doživljavaju kao znatno jače (39,40). Standardizirani i kontrolirani uvjeti nužni su pri određivanju i mjerenju stupnja boli. Utjecaji iz okoliša poput temperature, buke i ostalih aktivnosti mogu utjecati na percepciju boli (41,36). U našem istraživanju reakcije pacijenta mjerile su se odmah nakon izbjeljivanja, te poslije 6 i 24 sata, u istim uvjetima u kojima je obavljen zahvat.

Postoperativna preosjetljivost i bol česti su tijekom postupka izbjeljivanja vitalnih zuba. Preparati korišteni u istraživanju, oba vodikova peroksida u koncentracijama od 25 i 38 posto, pokazali su da podjednako pridonose postoperativnoj preosjetljivosti i boli. Te nuspojave teško je potpuno izbjeći, ali ih je moguće smanjiti pravilnim radom i sredstvima za desenzibilizaciju. Terapijom za ublažavanje dentinske preosjetljivosti utječemo na smanjenje pomaka dentinske tekućine ili živčanog odgovora potaknutog postupkom izbjeljivanja (42,43). Mnoge paste za desenzibilizaciju sadržavaju soli kalija. Za njih se smatra da ublažavaju odgovor intradentalnih živčanih završetaka (42). Sredstva s kalijevim solima koje smanjuju živčani odgovor i ekscitaciju, trebale bi biti učinkovitije od onih koja djeluju na principu zatvaranja dentinskih tubulusa. Smatra se da se sredstvima na temelju KNO_3 tijekom postupka izbjeljivanja ublažava dentinska preosjetljivost, ne kompromitirajući pritom estetske rezultate izbjeljivanja (44,45,46). Sredstva za zatvaranje dentinskih tubulusa, poput amorfnog kalcijeva fosfata, također smanjuju dentinsku preosjetljivost. To sredstvo može povećati gustoću minerala u caklini, smanjujući tako difuziju peroksida do živčanih završetaka (47).

Zaključak

U sklopu ovog istraživanja zaključili smo da postupak vitalnog izbjeljivanja zuba umjereno utječe na pojavu postoperativne boli, ali je teško procijeniti njezin stvarni intenzitet zbog subjektivnog i multidimenzijskog doživljaja boli. I korištenje VAS-a može utjecati na pogrešno tumačenje rezultata zbog različitog načina interpretacije boli svakog ispitanika. Ipak, smatramo da su opća razmatranja u ovom istraživanju opravdana. Klinička značajnost temelji se na spoznaji da se preosjetljivost nakon izbjeljivanja može pojaviti, ali bol je prolazna i može se uspješno spriječiti uporabom sredstava za desenzibilizaciju. Potrebna su daljnja istraživanja s različitim koncentracijama sredstava za izbjeljivanje, sa svjetlosnom aktivacijom i bez nje, kako bi se što preciznije ustanovili uzroci i posljedice postoperativne preosjetljivosti te mogući načini njezina smanjenja, uklanjanja i liječenja.

patient's interpretation of pain, a variety of emotional contributors may influence the subjective pain intensity value (35). Anxiety, fear and depression are indeed factors that can affect pain perception, as well as the subject's ability to find coping methods (36). As demonstrated by Kent, highly anxious patients expect more pain that they actually do suffer, probably due to an overestimation of previously experienced painful events (37). Dworkin and Chen found a significantly higher pain scores when an electric pulp test was performed in a laboratory setting compared with a dental clinic setting (38). Other findings suggest that fearful dental patients have a pain threshold and a pain tolerance similar to non-fearful patients with regard to non-dental stimuli, while they rate dental stimuli higher than the non-fearful subjects (39, 40). Standardized and controlled laboratory conditions are essential components of studies involving subjective pain evaluation. Environmental factors such as temperature, noise and external activity potentially influence pain perception (41, 36). In this study, patients' reactions were measured immediately after and 6 and 24 hours after the treatment in the same conditions as they were when the bleaching treatment was performed.

Postoperative tooth sensitivity and pain is a common side-effect of vital tooth whitening procedure. Both whitening agents were based on hydrogen peroxide (25% and 38%) and they showed that they equally contributed to prevalence of postoperative sensitivity and pain. It is hard to completely avoid these side-effects, but they can be alleviated by proper desensitization agents. Therapies for dentin sensitivity can reduce pain by either reducing stimulus evoked by dentin fluid shifts or by reducing the nerve response triggered by these stimuli (42, 43). Many desensitizing dentifrices contain potassium salts, which are believed to reduce the excitability of the intradental nerves (42) and they should be more effective than tubule-occluding agents. Incorporating KNO_3 containing agents into bleaching protocols appears to reduce the severity of dentin sensitivity without compromising the esthetics (44, 45, 46). Tubule-occluding agent, like amorphous calcium phosphate, has been shown to reduce dentin sensitivity. This agent may increase the mineral density of enamel hindering the diffusion of peroxide to the nerve endings (47).

Conclusion

In conclusion, we believe that the vital tooth bleaching treatment has a moderate impact on the occurrence of postoperative pain. The subjective and multidimensional experience of pain makes it hard to estimate its accurate level. Also, the use of VAS may result in false interpretations due to different meanings ascribed by individuals to pain descriptors. Nevertheless, we assume that the general observations of this study are still valid. The clinical importance is in the finding that the sensitivity after tooth bleaching can occur, but the pain is transient and can be successfully prevented by proper desensitization agents. Further studies with different concentrations of bleaching agent and presence of light activation are necessary to characterize the precise cause and consequences of postoperative pain and sensitivity, as well as the possible ways of its inhibition, prevention and treatment.

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Abstract

Aim: The aim of this study was to measure the level of postoperative sensitivity after two in-office whitening treatments. **Materials and Methods:** Twenty-two patients, divided in two groups of 11, took part in this study and they voluntarily agreed to a bleaching treatment. Two different *in-office* bleaching agents were used: Zoom2, based on 25% hydrogen peroxide and initialized by the light source from the same manufacturer, and Opalescence Boost, based on 38% hydrogen peroxide without the light initiation. The pain was evaluated by the visual analogue scale (VAS) and the data were recorded immediately, and at 6 and 24 hours after bleaching. **Results:** The data were analyzed by Wilcoxon Signed Rank Test. The difference between postoperative sensitivity after application of Zoom2 and Boost whitening agents, measured immediately after the treatment, 6 and 24 hours after bleaching, was not statistically significant ($p>0.05$). Both whitening treatments show the same prevalence of postoperative sensitivity, which was the highest immediately after the treatment and 6 hours later ($p<0.05$). Both agents show obvious appearance of postoperative sensitivity, which decreases to the values measured 24 hours after the treatment. **Conclusion:** The postoperative pain and sensitivity during and after both *in-office* whitening treatment agents with different hydrogen peroxide concentrations occur as one of the possible side-effects which were the highest immediately after the treatment and 6 hours later, and then decreasing to the values measured 24 hours after the treatment.

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