




## **MASTER THESIS**

# **A Comparison of the Effect and Contentment among Patients Receiving At-Home Bleaching with Two Different Treatment Approaches**

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Juni 2010

## **ABSTRACT:**

**Introduction:** Some bleaching modalities include an activation process with the utilization of heat or light to enhance the effect of bleaching gel. **Aim:** To compare the effect of treatment and the contentment among patients having received bleaching therapy with two different approaches. **Methods and Materials:** Six men and six women ranging from 22 to 61 years of age were included and divided into two groups. Opalescence 10% carbamide peroxide-gel was administrated in individual bleaching trays in Group I for two hours a day for fourteen days and in Group II for two hours a day for fourteen days and 2x1 hour in-office tooth whitening sessions. In Group II, the same bleaching agent and tray was used plus a light activation with an LED-lamp for forty seconds per tooth being treated. **Results:** Eleven patients completed the study. Group I had an average colour change of -5,36 steps on a modified VITA-scale and Group II -4,30. The patients in Group II seemed to be more satisfied with the treatment outcome compared to the subjects in Group I. **Conclusion:** Only speculations regarding the outcome of the study can be made. However, it appears as if patients receiving a more advanced bleaching therapy including the use of light become more satisfied with the end result compared to patients receiving at-home based whitening only. This seems to be the case even if patients given at-home bleaching therapy achieve an objectively better end result of the treatment.

**INTRODUCTION:** In the course of the last few decades vast changes have come about in the world of dentistry. First and foremost more patients have their own teeth longer, amalgam fillings have been replaced by tooth-coloured composites, ceramic crowns and porcelain veneers have been introduced as alternatives for their, in many cases, less aesthetic treatment predecessors and an increasing number of patients have received orthodontic treatment as children or adolescents.

At the same time, the perception of what is beautiful is constantly changing and an ever increasing proportion of us stride towards a healthier and younger appearance no matter the age or sex. In this context, more patients seek to slow down the ageing process of the dentition as well, requesting aesthetically flawless restorations when these are needed, thereby masking the signs of dental caries or plain wearing of the teeth to the lay man.

Alterations in people's perceptions of authorities have also come about, and the dentist has been put down from his or hers high horse in the local community; he or she is now considered a mere provider of dental health services and is as such obliged to fulfil patients' demands in an increasing manner, as long as it does not harm the patients' oral health. One of the highly popular treatments available is the bleaching therapy of vital teeth, and numerous treatment modalities and tooth whitening products matching this popularity are currently offered. For instance, professional dental bleaching can be conducted in a number of different ways, ranging from the hour-long in-office bleaching sessions using highly active and concentrated bleaching agents, to at-home based therapies spanning over a longer period of time. Professional bleaching regimes either utilize bleaching agents containing hydrogen peroxide or carbamide peroxide.

Different products are also found on the internet or elsewhere "over-the-counter" without offering professional supervision during the treatment. However, these so-called OTC-products may "have lower quality standards, be more acidic and have a shorter shelf life than other bleaching agents"(2). They are nonetheless marketed with great success.

Among Scandinavian dentists bleaching therapy was for many years a frontier considered not worth further investigation and patients requesting whiter teeth were rejected from this kind of treatment. In many cases, this was due to the dentists' personal perspectives of the therapy; tooth whitening was considered a vanity treatment only suitable for the luxurious housewives

of Hollywood, and at the same time, the risk of irreversibly damaging the teeth during such a therapy was believed to be immense.

In the last two decades, however, this perception has gradually changed as continuous streams of scientific evidence against such beliefs have been presented, thereby creating a better foundation for the general practitioners to pass judgement upon different bleaching therapies. The nightguard vital bleaching technique introduced by Van B. Haywood in the late 1980s is now considered the treatment modality of choice in most cases where indications for tooth whitening are found.

### **Carbamide peroxide; mode of action**

The fashion in which carbamide peroxide(CPO) bleaches the tooth substance is at present not fully understood. However, most researchers agree upon the chemical reactions of a ten percent CPO gel within the tooth substance described below.

Carbamide peroxide penetrates the enamel and dentin of the tooth within 5-15 minutes after administration(1). The bleaching agent splits and yields 1/3 hydrogen peroxide and 2/3 urea, a chemical reaction caused by mouth temperature. During the initial five minutes of degradation nearly fifteen percent of the bleaching agent is split, followed by an exponential rate of degradation (3). When incorporating reservoirs in the tray design, 52 percent of the active gel is still active after two hours. Six hours after administration, 24 percent of the active agent remains(4). In other words, the process reaches its peak of activity within the first two hours after administration. Although the release of hydrogen peroxide decreases considerably after this, the bleaching agent stays active for the following eight hours after application, giving rise to a total effective time of approximately ten hours(5).

Hydrogen peroxide( $H_2O_2$ ) is very unstable and the molecule splits to perhydroxyl( $HO_2\cdot$ ) and oxygen radicals that oxidate long and strongly coloured molecules within the extra cellular matrix of the tooth substance(6). The long molecular chains are split to shorter chains and hydrogen peroxide decomposes to water and oxygen. The short molecular chains will reflect light in a different manner compared to their long predecessors and the tooth substance appears lighter. A temporary increase in oxygen concentration within the tooth substance gives rise to a slight dehydration of the hard tissues by which the tooth's colour could be affected. These oxygen radicals are said to reduce the bonding strength between the tooth and

a restoration and prevent proper curing of new composite materials. When the extra oxygen within the tooth substance has been released, normally within two weeks of the bleaching therapy, bonding strength returns to normal values(1).

After having stabilized the hydrogen peroxide in CPO, urea becomes ammonia and carbon dioxide. In addition to stabilizing the active component of the bleaching agent urea also elevates the gel's pH value, thereby decreasing the erosive potential compared to products containing hydrogen peroxide only(1).

Every tooth has its own lightness potential, beyond which further esthetical improvement is not expected should the treatment be continued. The risk of over-bleaching the tooth and rendering it irreversibly damaged by the oxidating action of the bleaching agent gives natural limitations when undertaking the therapy. Over-bleached teeth will lose their natural translucency and appear white and opaque like porcelain plates due to the structural damages in the enamel and dentin. What happens within the tooth substance, and if this is a permanent damage or a reversible reaction, is not fully known.

Another potential adverse effect following a tooth whitening program is hypersensitive teeth; the presence of the bleaching agent in the dentinal fluid and dental pulp can cause a so-called chemical hypersensitivity or in endodontic terms a reversible pulpitis. This is a frequently observed side-effect reported by nearly 2/3 of all patients, but when the stimulus of the agent is removed, the inflammation also subsides in most cases. In other words, no irreversible changes in the dental pulp are created when 10% CPO is used(7). Potassium nitrate has been added to some bleaching gels because of the molecule's ability to penetrate the tooth's hard tissues and reduce the transmission of stimuli via afferent nerves, thereby also minimizing or even eliminating hypersensitivity. Fluoride supplements can also reduce the tooth's sensitivity. In cases where the bleaching tray is not properly adjusted to the patient's teeth or the tray material is too rigid, even a mechanical hypersensitivity can develop(1).

The oral soft tissues can also be affected by the bleaching agent or tray and gingival irritation during or directly after the treatment is frequently observed. This is due to either poor tray design or faulty application of the bleaching agent(8). These lesions heal quickly after the stimulus has been seponated.

The extent to which bleaching works depends on the type of stain, its etiology, the length of time the stain has been present, the bleaching agent itself, how frequently it is applied, how long it remains on the teeth and the concentration of the bleaching gel used.

Following a bleaching treatment, patients are generally satisfied with the treatment outcome for one to three years; 74% contentment after 1,5 years, 62% after three years and a contentment of 42% seven years post-treatment has been found(9). But what if the home based nightguard vital bleaching technique was to be done in a somewhat more “high tech” fashion involving a short light activation of the bleaching gel? Could this affect the final treatment outcome? And more importantly, would the patients’ general perception of the outcome in such a treatment regime be any different?

**AIM:** To determine if patients bleaching their teeth at home with a 10% CPO-gel were less satisfied by the treatment outcome compared to patients having their teeth whitened both in the clinic, using the same bleaching agent and tray, with the additional use of a standard LED-lamp, and in the comfort of their own home. The treatment outcome in the two bleaching regimes was also compared.

**HYPOTHESIS:** The two groups will achieve comparable levels of tooth whitening and will be equally satisfied by the treatment outcome.

## **MATERIALS AND METHODS:**

### **Subjects**

Recruiting the patients was done firstly by the use of posters(Appendix 1) on several locations at the University Campus. Later on, a message was posted on the University Intranet and the bulk of patients were enlisted. Three patients already receiving treatment by students at the University Dental Clinic were also recruited. When the total number of possible subjects reached 61, the recruiting period was ended.

Out of the 61 volunteers, one proved not to meet the inclusion criterions due to a suspected pregnancy and two patients withdrew from the study after having been given more information regarding the possible side effects of the therapy. The remaining 58 subjects were screened in the course of the first months of the fall semester of 2009.

During the screening session the patients were evaluated by the criteria set for inclusion or exclusion from the study. For participation in the study patients had to have reached the age of eighteen and have four to six teeth in need of bleaching therapy in the anterior area of the maxillary dental arch. The A3 colour sample from a VITA-shade guide (Table 1) was made the lightest tooth colour for inclusion.

Pregnant and nursing patients were automatically excluded from the study (EU recommendation). If routinely use of tobacco products such as cigarettes or snuff was discovered, this also led to absolute exclusion from further participation. Restorations such as fillings or crowns in the anterior area of the upper jaw in particular, also meant that the subjects were not suited for this particular study.

A grand total of twelve subjects were found suited for further attendance. The group consisted of six men and six women, with ages varying from 22 to 61, and a mean age value of 32 years. All patients had received dental treatment in the course of the last two years prior to the study, but only one had discussed tooth whitening with her regular dentist.

### **Pre-Treatment phase**

Further information regarding the study was sent to the patients by e-mail (Appendix 2) and arising questions were answered before continuing the study. A thorough clinical examination for all twelve patients followed. This included an examination of the whole dentition plus bitewing radiographs, measurement of the pocket depth and electronic sensitivity testing of the teeth already scheduled for bleaching therapy. Clinical photos with colour references were also taken with the University Dental Clinic's Canon EOS 550D camera. The auto focus function of the camera was used. Colour references were taken with the aid of a VITA-shade guide arranged from lightest to darkest according to manufacturer (Table 1). An alginate impression of the patient's upper jaw was finally taken for fabrication of a custom made bleaching tray.

<b>Table 1; VITA-scale arranged from lightest to darkest according to manufacturer</b>																
<b>Colour</b>	B1	A1	B2	D2	A2	C1	C2	D4	A3	D3	B3	A3,5	B4	C3	A4	C4
<b>Step</b>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Tooth colours were taken under the standard ceiling lamps supposedly closely matching day light. During this stage of treatment the operation lamp was not utilized. Shades were held towards the teeth for short periods of time and blue napkins were used for resetting the eye's ability to perceive different colour shades between measurements.

In some cases, a treatment need other than tooth bleaching was found during the course of the examination. Patients were in these cases recommended to either contact their regular dentist for an appointment or to enlist at the University Dental Clinic and get the treatment needed performed by other undergraduate students.

After the clinical examinations the patients were randomly listed and divided into two groups by throwing a dice for each patient on the list. A result from one to three indicated a group one patient and a result from four to six would include the patient in the second group. The selective process ended as soon as one of the two groups consisted of half the total number of suited cases.

The bleaching trays were ordered from dental technician Hugo Ellingsen in Tromsø, after thorough instructions for the reservoir applications; the approach was based on the use of resin-made reservoirs applied to the buccal surfaces and extending 1mm over the incisal ridge of the teeth that were to be treated. To ensure the maximal retention of the bleaching agent possible, all models were wetted and trimmed at the gingival margin using plaster knives prior to the reservoir application.

Two of the bleaching trays were fabricated at the University Laboratory by using Ultradent® LC Block-Out Resin, BioBleach® soft tray plates, Ø 125mm x 1,0mm, and the vacuum tray-forming machine MINISTARS® from Scheu Dental Technology. In this process the trimmed model with reservoirs was placed in the fixed part of the machine whilst the thermoplastic plate was fixed and heated in the machine's moveable arm. After heating the plate 25 seconds, the moveable arm was swung on top of the plaster model and vacuum built inside the machine's sealed chamber, pressing the warm plate to the model. At the end of the procedure the bleaching tray was trimmed so that it's borders edged on the trimming on the buccal side of the plaster model and a few millimetres superior of the palatal gingival border(Appendix 3).



## **Treatment phase**

All patients were treated with the same bleaching agent administered by individually fitted bleaching trays: Opalescence® bleaching gel by Ultradent Products Inc containing ten percent carbamide peroxide, 1100ppm fluoride ion(0,11%) and 3% potassium nitrate. The gel had a pH-value of approximately 6,5.

Group I were to receive at home bleaching for two hours a day during two weeks using 10% CPO-gel yielding a baseline active therapy of 28 hours. Group II would be given the same treatment as Group I, but were also to receive 2x1 hour in-office tooth whitening sessions, using the same bleaching agent and tray. In these sessions the bleaching agent was administered and then activated for forty seconds per tooth being treated by the use of the standard LED-lamp(Bluephase® by Ivoclar Vivadent®) utilized in the University Dental Clinic. This procedure was done on the patients in Group II on their first and last bleaching session and had a duration of one hour each.

During the treatment of the two groups all patients received their first control half-way through the therapy, i.e. after seven days of bleaching. Directly after completing the active treatment a new control was carried out. This session included colour evaluation of the bleached teeth and references were noted. In the second group, the tooth colour was evaluated prior to the last bleaching session at the clinic because of the potential rapid relapse following the process. Clinical photos were also postponed to the final control of the treatment outcome, which took place two weeks after the active phase, because of the post-treatment colour stabilisation occurring during which a slight colour change is expected.

Tooth sensitivity testing was performed in the same manner as in the pre-treatment examination. In addition, two questionnaires(Appendices 4 and 5) were completed by the patients; the first directly prior to the treatment start and the second during the final control of the bleaching result approximately two weeks after the treatment had ended.

During the second week of the study one of the patients in Group II decided not to follow the treatment regime and instead of bleaching his teeth two hours a day, used the bleaching tray by night the last seven days of the period. This led to instant exclusion from the study since the end result, though up-lifting, was not possible to compare with the other subjects' post-treatment tooth colour.

## RESULTS:

Eleven patients; six women and five men ranging from 22 to 61 years in age completed the bleaching treatment of 6-8 teeth. The participants in the study received 28 and 30 hours bleaching therapy in the first and second group respectively. A mean value change from 10 to 5,12 on the VITA-scale, in other words  $-4,88$  steps, was achieved in the two groups combined (Table 2, Appendix 6).

	Baseline		Change after 2 weeks		After 4 weeks	
	MV	Median	MV	Median	MV change	Final MV
Patient 1	13,5	13,5	-3,17	-2,5	0,67	11
Patient 2	7,5	7	-5,17	-5	0,67	3
Patient 3	15	15	-6,34	-6,34	0,67	9,33
Patient 4	7	7	-5	-5	0,17	2,17
Patient 5	10,67	10	-7,67	-7	0,83	3,83
Patient 6	14,33	14	-7,83	-9	0	6,5
Average Group I	11,33	11,75	-5,86	-5,67	0,5	5,97
Patient 7	8,17	9	-2,92	-2,5	0	5,25
Patient 8	6,83	7	-4,17	-4	0,17	2,83
Patient 9	8,42	9	-4,75	-3,5	0	3,67
Patient 10	8,25	5	-4,75	-3,5	0,25	3,75
Patient 11	10,33	9	-5,33	-5,5	0	5
Average Group II	8,4	9	-4,33	-3,5	0,01	4,1
Combined	10	9	-5,19	-5	0,31	5,12

The first group consisted of six patients with an average value on the VITA-scale of 11,33. This corresponded to a mean tooth colour matching the B3 shade. The median tooth colour of the group was, however, 11,75, the best match of the scale being the A 3,5 shade. Two weeks of active treatment yielded a mean colour change of  $-5,86$  steps on the scale, however with an average colour relapse of  $+0,5$  the final mean value on the VITA-scale was 5,97.

The average tooth colour in the second group was the D4 shade featured on the VITA-scale, the mean value from the start being 8,4 out of 16 among the five patients in the group. The median colour shade was 9,0 on the scale, corresponding to the A3 shade. After the bleaching therapy the mean colour change was  $-4,33$ , and with a mere mean colour relapse of  $+0,01$  steps on the scale, the final mean value was 4,1.

The mean canine tooth colour (Table 3) at baseline was 12,33 in Group I and 12,35 in Group II. In other words, both groups had a mean canine colour shade of A3,5 at baseline. After active bleaching therapy for two weeks the Group I patients showed an average improvement in tooth colour of -6,5 steps on the VITA-scale, and with a relapse of +1,01, the final tooth colour was 6,92. This closely matched the C2 shade of the scale.

The final Group II post-treatment result was a mean value of 6,7 of total 16. The average colour change directly following two weeks of treatment was -5,85, the relapse after ending the active treatment was, however, only +0,2.

**Table 3; Treatment result when comparing canine teeth only**

	Baseline	After 2 weeks	After 4 weeks	
	MV	MV change	MV Change	Final MV
Patient 1	13,5	-3,5	1	11
Patient 2	10,5	-7,5	2	5
Patient 3	7	-5	0,5	2,5
Patient 4	13	-8	2	7
Patient 5	15	-7	1	9
Patient 6	15	-8	0	7
<b>Average Group I</b>	<b>12,33</b>	<b>-6,5</b>	<b>1,01</b>	<b>6,92</b>
Patient 7	13	-5	0	8
Patient 8	11,25	-7,25	0	4
Patient 9	11,5	-1,5	0	10
Patient 10	11	-5,5	0	5,5
Patient 11	15	-10	1	6
<b>Average Group II</b>	<b>12,35</b>	<b>-5,85</b>	<b>0,2</b>	<b>6,7</b>
<b>Combined</b>	<b>12,34</b>	<b>-6,2</b>	<b>0,68</b>	<b>6,82</b>

The pre- and post-treatment questionnaires were used primarily to compare the level of contentment among the subjects in the study, but questions were also posed regarding the patients' motivation to whiten their teeth. For instance the assertion "My personal motivation for maintaining a good oral health will improve, should the colour of my teeth be lighter" was made. Most patients in both groups fully agreed, disregarding subjects who were dental practitioners (N=2), that is.

When being asked to grade how big an impact teeth has on a person's general appearance on a scale from one (of little importance) to five (very important), a mean value of 3,82 was found. This indicates that the subjects in general were moderately focused on the appearance of

people's teeth and that they were not obsessed with the idea of a bright smile as a way of improving one's beauty.

When answering the question "How satisfied are you with the end result, on a scale from 1(not at all), to 5(very satisfied)?" on the post-treatment questionnaires all patients showed an overall contentment of 4,36. The Group I patients reported an overall contentment of 4,25, while the Group II patients reported a mean level of satisfaction of 4,75. The result also differed between the groups when the question "Does the bleaching result match your expectations?" was answered; among the Group I patients an overall score of 3,66 of total 4 was noted, while the second group had a score of 4. All patients would, however, recommend the treatment to their acquaintances, if they were asked for an opinion.

During the in-office bleaching sessions, half of the patients reported the forty seconds LED-activation as unpleasant because of the heat developed in the process. This implies either a pulpal response to the increased temperature or a shift in the in- or out-flux of the dentinal fluid, giving rise to the dental hypersensitivity as described by Brännström(10). When conducting electric sensitivity testing during the post-treatment appointment, however, no changes were found compared to the pre-treatment registration; all post-treatment ratings were within the ranges of pre-treatment records. This result corresponds to the conclusions drawn by Fugaro et al in 2003(11). Also, none of the patients reported having hypersensitive teeth following the active treatment phase.

## **DISCUSSION:**

The study was based on the use of a ten percent carbamide peroxide gel in individually fitted bleaching trays. This decision was based on the current knowledge of bleaching methods and materials researched by among others Bruce A. Matis: "There are only five tooth whitening products accepted by the American Dental Association as safe and effective. (...) All of them use ten percent carbamide peroxide dispensed in trays"(7). As further stated by Dr Matis, the use of reservoirs in bleaching trays are a matter of controversy in up-to-date tooth whitening therapy; "(...) from a clinical standpoint, placing a reservoir in trays made no difference in color." However, since more bleaching gel is left unaccounted for after the use of bleaching trays without a reservoir, and therefore is believed ingested, the recommended tray design still has a reservoir placement as an important component. This is in accordance to the first instructions given for tray tooth whitening(1).

The two groups were established by throwing a dice and determinants such as gender, age and tooth colour not taken into consideration in this process resulted in groups showing inequality in the factors mentioned. For instance, the mean pre-treatment colour was approximately three steps darker in Group I than in Group II; the mean value of tooth colour was 11,33 in Group I while only 8,4 in Group II. The latter was actually below the general inclusion criterion of A3 that corresponds to the 9<sup>th</sup> step of the scale. However, great equality in canine pre-treatment colour was found.

The average age in Group I was notably higher than the situation in Group II. This might indicate teeth more resistant to bleaching treatment in the first group than in the younger patients generally found in the second group. That being said, finding the number of patients needed for the study proved to be a challenge as the bulk of the screened subjects were quite young, and by that had only minor, if any, discolouration of the teeth in the area of interest. To solve this, extending the promotion area of the study beyond the University Campus could have been done to enlist a greater number of patients in a more varied age group. The limited amount of time at hand for the project made such a step difficult to carry through.

When comparing the canine teeth only, the two groups showed, as already stated, great equality in tooth colour prior to the bleaching therapy; Group I: 12,33, Group II; 12,35. The mean colour change after two weeks of active tooth whitening showed a difference of -6,5 in the first group and -5,85 steps in the second. However due to a greater relapse in tooth colour in Group I, the final treatment outcome was quite similar for both groups, the difference in end colour being only 0,22 steps on the scale.

Continuing the comparison of canine teeth, the colour relapse found when was markedly smaller in Group II; +0,2, compared to Group I; +1,0. The same trend is seen when comparing the colour relapse in general of all teeth between the two groups. One of the possible reasons for this is the bigger colour change noted after fourteen days of bleaching in Group I, thereby giving room for a greater relapse in this group.

That being said, the number of subjects needed for statistical comparison of the end results in the two groups is far from reached. However, statistical comparison was never the intention of the study itself, bearing in mind its “pilot-study” branding. Mere chance may by that have effected the end results and nothing else than speculations regarding the final outcome can be

made at this point. Nevertheless, it appears as if the Group II patients were more satisfied with the treatment result compared to the subjects in Group I. This is interesting when considering the different end results in both groups; Group I had a mean colour change of -5,36 steps on the scale, while Group II had a mean colour change of -4,3. In spite of this, the patients who received bleaching therapy both at home and at the clinic were more content than the ones receiving at home treatment only.

To explain why this was found is not a task easily undertaken and only assumptions can be made. It could for instance be that the Group II subjects felt that their bleaching therapy was conducted in a more professional manner when having the treatment done chair-side by the hands of a dental practitioner, in comparison to the, in many ways self-performed, at-home treatment. Further on, this could trigger a sense of being taken better care of as a patient, which in turn probably affects the post-treatment contentment to a certain degree.

Taking into consideration that half of the patients in Group II reported a painful sensation during the forty seconds LED-activation of the bleaching agent, one might question whether or not this has rendered the dental pulp irreversibly damaged. According to a review article concerning this topic(12), it has been shown that the temperature increase tolerated in the dental pulp before causing irreversible damage should not exceed 5,5 degrees Celsius. If this is the case after utilization of the LED-lamp for forty seconds, 3,5 times the damage is to be expected following a standard three-layered class II-composite restoration, the curing of the bonding included. However, if there was an irreversible damage caused to the pulp, this was not clinically detectable by using the electric sensitivity tester; all pre- and post-treatment records were within the same intervals.

Regarding weaknesses of the study design some points can be made. For instance, the bleaching trays utilized in this study were not all optimally designed. Especially differences were found in the thickness of the layers of LC Block-Out Resin. The resin was also generally not placed in even layers. Since all trays were received only one day prior to the start of the treatment phase there was no time to improve them before they were to be used.

Furthermore, tooth colour was only measured with the naked eye, since technical aids such as a colourimeter or digital analysis were not available during the process. Therefore the most subtle changes were impossible to measure, and only the shade or shades most closely

matching the tooth colour were noted. Since the study was performed in the autumn, and in Tromsø, day light became increasingly hard to come by as the active treatment phase proceeded. Because of this, colours had to be taken under the standard ceiling lamps supposedly closely matching day light. The operation lamp was not utilized. This is a situation matching most clinicians' working conditions, but it may nevertheless be considered a weakness of the study design.

In addition, the eye's ability to perceive different colour shades changes during the day and intra-individual variations in colour evaluation are frequently found, as well as inter-individual differences. To reduce the latter variations to a minimum, as many screenings as possible were done with more than one pair of eyes passing judgement. As already stated, shades were held towards the teeth for short periods of time and blue napkins were used for resetting the eye's ability to perceive different colour shades between measurements. This was done to diminish the intra-individual differences as much as possible.

All patients were introduced to their bleaching regime both orally in the clinic directly prior to the treatment start and by written information before attending the appointment. However since complete supervision of the treatment was not possible, one can only assume that the eleven subjects who completed the study followed the instructions given. Such a situation would indicate that the patients in Group II received two hours more bleaching therapy than the patients in Group I. This could increase the amount of colour change achieved in Group II, but the theoretical additional effect would in any case be minimal and therefore not possible to perceive for the bare eye.

Questions regarding the ethical aspect of providing dental bleaching as an every-day treatment in the dental clinic have been raised. Critiques claim that tooth whitening is a populist treatment and a mere milking-cow for dentists who seek to exploit their patients when given the chance to earn money for practically no effort. Furthermore, the tooth whitening procedure is sometimes considered as much a therapy for a wounded vanity as a treatment for physiological changes found within the tooth substance rendering it with a notably different colour.

However, in an ever increasing number of cases aesthetical considerations lay the foundation for the treatment carried out by the clinician. In these cases aesthetics is gazed upon as an

accepted clinical reason to undertake the procedure, by most dentists. This should not only be the case when considering invasive therapies such as fixed prosthodontics in the anterior area of the mouth or ceramic laminates in the same region but also when more conservative treatment modalities such as dental bleaching could be chosen to address the patients' main concern. This view is supported by one of the key sentences found in the modern version of the Hippocratic Oath: "To practice and prescribe to the best of my ability for the good of my patients, and to try to avoid harming them."

Quoting WHO's health definition of 1948; "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity", it becomes increasingly evident that the bleaching of aesthetically discomforting teeth can be a useful mean to alter a person's self-perceived state of health in a positive manner.

It is further important not to underestimate the patients' own common sense; even if a treatment is available in an ordinary dental clinic this doesn't necessarily indicate that everyone considers the treatment right for them and wants to have it done. One study for instance, conducted by Shaw et al(13), shows that orthodontists more often define a treatment need than the patients do themselves. This could also be the case in the matter of tooth discolouration, the "bleachorectic" patients not included, that is. At the end of the day however, the dentist is the one who separates the suitable subjects for any therapy, not only dental bleaching, from the individuals who are found to be less fit for a specific treatment.

#### **CONCLUSION:**

It appears as if patients receiving a more advanced bleaching therapy including for example the use of light, actually becomes more satisfied with the treatment outcome compared to patients receiving at-home based whitening therapy only. This seems to be the case even if the patients given at-home bleaching therapy achieves an objectively evaluated better end result of the treatment. However, the results of this pilot-study are not by far statistically validated, and can therefore only be regarded as an educated guess.



## **Acknowledgements**

Sincere thanks to Åhrén Dental Consult, Hagersten, Sweden, for sponsoring the bleaching gel utilized in this study.

Sincere thanks also to dental technician Hugo Ellingsen AS and to the employees at the University Dental Clinic.

## **Appendices**

1. Posters used in recruiting patients to the study.
2. Further information regarding the study sent by e-mail to participating patients.
3. Pictures showing the fabrication of the bleaching trays' reservoirs step by step.
4. Pre-Treatment questionnaire.
5. Post-Treatment questionnaire.
6. Treatment result in patient 9.

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