TouchWhite—
Next-generation tooth whitening

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_White teeth have long been cosmetically desirable. Studies suggest that at least a third of dental patients are not satisfied with the colour or aesthetic appearance of their natural teeth.[1–3] As demand for aesthetic dental care has grown steadily over the years, many methods have been introduced to whiten teeth that are naturally off-white or that have become stained through smoking and dietary factors.[4, 5]

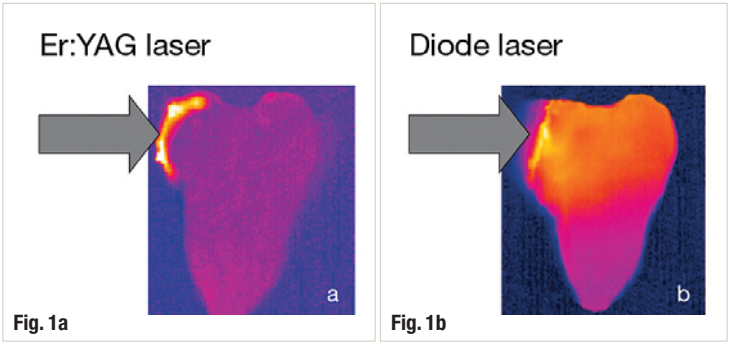

Fig. 1a

Fig. 1b

Figs. 1a & b_Lateral view thermal images of a tooth under Er:YAG (a) and diode (b) laser illumination.

The most basic methods for enhancing the appearance of discoloured teeth involve the application of gels, pastes or liquids that are mechanically applied to the tooth surface to remove stains through an abrasive process. More effective methods involve tooth-whitening products that activate a chemical bleaching effect during contact with the stained teeth.[6]

Many dental practitioners also employ lasers or other high-intensity light sources to enhance the bleaching process and reduce the overall treatment time. However, not all laser-assisted tooth-whitening methods are equal.

A more effective and patient-friendly tooth-whitening solution is presented in this paper. The novel and proprietary TouchWhite method (Fotona) eliminates the main disadvantages of other laser-assisted whitening methods. The procedure is simple to perform, requiring only a standard water-based bleaching agent that is heated by means of a pulsed Er:YAG laser source. The key to the superior effectiveness of the procedure lies in the unique nature of this particular laser wavelength and the specific TouchWhite treatment parameters.

_TouchWhite versus traditional laser-assisted tooth whitening

In order to understand the reason that TouchWhite is superior to other bleaching methods, it is helpful to take a closer look at some of the main concerns and disadvantages of typical laser-assisted bleaching solutions:[7]

_To start with, other laser bleaching systems require a specialised (and more costly) bleaching gel that contains a special high-tech blend of light-absorbing particles, together with a compatible laser device that emits light at the exact, corresponding absorption wavelength of the absorbing particles.

_It can be inconvenient and more difficult to clean teeth that have been coloured by gels that are infused with these particles after the procedure.

_The dental practitioner has little choice but to trust that the added light-absorbing particles are non-toxic, biocompatible, and effective enough at absorbing laser light to guarantee a safe treatment.

Unfortunately, the density of the light-absorbing particles in laser-enhanced bleaching gels is typically such that light from the laser source is not fully absorbed in the relatively thin layer of gel that is applied to the tooth surface. Owing to this inefficient light absorption, some of the laser energy will be transmitted directly into dental tissues. This can lead to an undesired heating of the patient's whole tooth and dental pulp, possibly leading to pain and irreversible damage. Indeed, some of the treatment procedures recommend applying laser light to a tooth until the patient reports feeling pain.

The TouchWhite method uses a very different approach, which eliminates all such concerns

about safety owing to the unique way in which the Er:YAG laser wavelength interacts with the bleaching gel.

Before taking a closer look at the TouchWhite method, however, let's first quickly review some of the basics of dental bleaching gels.

_Bleaching gel effectiveness

Bleaching gels consist mainly of water and a bleaching agent containing hydrogen peroxide (H_2O_2). Water is the principal component of bleaching gels and commonly accounts for more than 50 % of the gel by weight. The bleaching agent itself is present in an amount ranging from 3 to 50 % by weight.

In a typical tooth-whitening process, the bleaching gel is applied to the teeth and allowed to remain in contact for up to an hour. The intensity of the bleaching effect depends on both the duration of contact and the rate of activation of the gel, which can be increased by raising the temperature. Heat serves to increase the rate of activation of free radicals in H_2O_2, accelerating the speed at which whitening can be achieved.[8,9]

In particular, higher gel temperatures facilitate:

_faster generation and greater mobility of H_2O_2 in the bleaching gel;
_decomposition of H_2O_2 into OH and O;
_an enhanced diffusion rate into the tooth; and
_an enhanced reaction time between the active peroxide species (radicals of OH or atomic oxygen O) and the compounds of the enamel and dentine.

Typical temperature increases in the gel that are desirable for dental treatments are between 10 and 40 °C.

_Light absorption

The use of high-intensity light for increasing the temperature of H_2O_2 to enhance the chemical bleaching of teeth was first reported by Abbot in 1918.[10] In modern dental offices, lasers are frequently used to deliver a controlled beam of high-intensity light to thermally activate the bleaching gel.

Many manufacturers of laser- and light-based bleaching systems claim that there is improved light absorption, reduced tooth heating, and even photochemical activation of the bleaching gel following the addition of an activator, absorber or colourant to the gel.[11,12] In principle, this concept does improve the absorption efficiency, but not enough to alleviate all safety concerns.

In a systematic review (conducted before the introduction of the TouchWhite method), Buchalla and Attin[13] concluded that there was no real evidence to support a photochemical bleaching effect and that the enhanced rate of bleaching with laser- or light-based treatments was the result of photothermal activation. Additionally, they warned that activation of bleaching agents by light or laser energy may have an adverse effect on pulpal tissue owing to an increase in intra-pulpal temperature exceeding the critical value of 5.6 °C. This is because most laser wavelengths are not fully absorbed in the relatively thin layer of the gel that is deposited on the tooth surface. As a result, the laser energy is transmitted directly into the dental tissue, possibly leading to pain and permanent damage.

_The TouchWhite concept

The TouchWhite method uses a very different approach, which eliminates these concerns by making optimum use of the unique properties of the Er:YAG laser wavelength, which is the laser wavelength that is most highly absorbed in water. Water is the major component of dental bleaching gels, and owing to the nearly instantaneous absorption of the Er:YAG beam in water, the need for having special light-absorbing particles in the gel is removed entirely. All of the Er:YAG laser energy is used for direct heating of the bleaching gel, thus preventing any risk of thermal injury to the tooth.

During the application of the Er:YAG laser during TouchWhite, the beam of light is fully absorbed in the first 10 to 50 µ of the gel, and deeper gel layers are subsequently heated by means of thermal diffusion away from the laser-heated surface layer.

There is no direct heating of dental tissue or pulp, as is the case with other laser-assisted whitening methods. The TouchWhite procedure, in fact, represents the safest, least invasive laser-assisted tooth-whitening method available.

It is also worth noting that with TouchWhite, the laser parameters are customised for bleaching treatments so that the laser fluence of each laser pulse is below 0.5 J/cm^2, which is well below the ablation threshold of dental tissues. Since the ablation threshold for enamel is approximately 3.5 J/cm^2, there is no risk of accidental damage.[14]


Fig. 2a

Fig. 2b

Figs. 2a & b_Before (a; A3 VITA shade guide) and immediately after (b; A1 VITA shade guide) images of the TouchWhite Er:YAG laser-assisted whitening procedure.

Figure 1 shows the lateral view thermal image of a tooth during Er:YAG and diode laser (810 nm) illumination of bleaching gel.[15] As can be seen in the first image (Fig. 1a), the Er:YAG wavelength is fully absorbed by the gel, and there is no direct heating of the underlying tooth.

In contrast, the diode wavelength is poorly absorbed in the gel and the transmitted light directly heats the entire tooth. For this reason, the Er:YAG laser power is utilised more effectively and the gel can be heated to higher temperatures without compromising the safety of the tooth or the pulp. As a consequence, the tooth-whitening speeds can be safely increased by five to ten times with TouchWhite.[15]

_The TouchWhite procedure

The Fotona TouchWhite bleaching kit contains gingival protection, bleaching gel and after-bleaching care material, packed in a syringe. The complete bleaching kit should be stored in a refrigerator (3–8 °C). Before application, the kit is taken out of the refrigerator, the gel is mixed in the amount needed for the procedure, and the mixed gel is left to rest for four to eight minutes at room temperature.

The gel is then applied to the teeth with a spatula in a predetermined sequence #11-21-13-23-24-14-15-25-12-22 for the upper teeth and #33-43-34-44-35-45-32-42-31-41 for the lower teeth.

Each tooth is irradiated for 20 seconds in the same sequence as the gel application. The parameter settings for the Fotona Er:YAG laser are as follows: frequency 10 Hz, power 0.55 W, pulse duration VLP, handpiece R093. The handpiece is moved in a sweeping motion across the gel surface. In the unlikely event that pain or sensitivity occurs in any tooth, the handpiece should be moved to the next tooth immediately.

Pay careful attention not to irradiate two neighbouring teeth at the same time. The whole procedure is repeated three times so that every tooth is irradiated three times for 20 seconds each.

Once the three-cycle illumination of all teeth has been completed, the gel is removed with an aspirator and the tooth surface is thoroughly rinsed with a water spray. The colour is checked with a shade guide and shown to the patient. The procedure can be repeated up to three times in a single appointment if necessary.

_Research supporting TouchWhite

In vitro measurements and clinical studies have shown that with TouchWhite, whitening treatment times can be safely shortened to between one to two minutes, down from ten to 15 minutes when no laser activation is applied. The method is effective and safe, as confirmed by temperature measurements in the pulpal chamber.

The TouchWhite method was first proposed and studied by the Laser and Health Academy in partnership with the European manufacturer Fotona. Later, the Aachen Dental Laser Center (AALZ) in Germany performed a detailed *in vitro* study of the temperature elevation in the pulp chamber under different Er:YAG laser-whitening scenarios, fol-

lowed by a clinical study of Er:YAG laser-assisted whitening.[15] Both studies confirmed the TouchWhite method to be safe and highly effective in shortening the activation times of the bleaching gels.

Another introductory clinical study conducted at the Kozarac Dental Clinic in 2009 tested an Er:YAG laser-assisted whitening method in which the bleaching gel was illuminated for three sequences of 20 seconds, with ten-second intervals between each sequence (according to the studies conducted by Fotona and AALZ, this illumination mode can shorten the bleaching time from ten to 15 minutes to 1.5 to two minutes).[16] Five patients with 16 intrinsically stained teeth (12 vital and four non-vital) were treated with Fotona tooth-whitening gel (35 % H_2O_2). One to three treatment sessions were conducted depending on the intensity of discolouration.

The results of this initial study confirmed that the Er:YAG laser applied in a three-sequence mode can be used safely and effectively for the bleaching of discoloured vital and non-vital teeth. Since then, the TouchWhite procedure has been performed on numerous additional patients.

In comparison with diode and Nd:YAG bleaching, the Er:YAG laser-assisted whitening method has proven to be more comfortable for patients, while achieving the same or better whitening efficacy in shorter treatment times.

As an example, Figure 2 shows before and after photographs for one of the cases.

_Proper diagnosis—The key to success

As with all medical treatments, the key to success with TouchWhite is proper diagnosis. Dentists are often asked by patients to provide an expert opinion on the causes of tooth discolouration. To answer this question properly and to provide the patient with the best possible treatment options, it is essential to understand the relationship between tooth development and the various agents that can cause improper and undesirable tooth colour. There are more than 50 different conditions operating locally or systemically that can cause developmental disturbances in tooth formation.

Each cosmetic dental practitioner must be able to recommend, based on prior knowledge and experience, which procedure to perform in order to achieve the most desirable results for the patient—whether through bleaching or prosthetic crowns and veneers.

Experience with TouchWhite demonstrates that the conditions that can be successfully treated with the procedure are:

_intrinsic discolouration in the formative phase (fluorosis—brown or opaque, and tetracycline staining); and
_intrinsic discolouration in the post-formative phase (colour due to pulpal necrosis, iatrogenic factors due to root and crown fillings, and discolouration due to ageing).

For other intrinsic discolourations, whether in the formative or post-formative phase, prosthetic solutions should be considered.

_Conclusion

The TouchWhite process makes use of the unique properties of the Er:YAG laser wavelength, which is well absorbed by water—the major component of aqueous bleaching gels—thus eliminating the need for special light-absorbing particles in the gel. Since the Er:YAG laser beam is fully absorbed by the bleaching gel, it consequently does not directly heat the patient's hard tissue or pulp.

Furthermore, the laser parameters are adjusted so that the laser fluence of each laser pulse is significantly below the ablation threshold for dental tissues. Because of these optimal laser characteristics and protective parameter settings, the TouchWhite procedure represents the safest, most effective and minimally invasive laser-assisted tooth-whitening method available._

Editorial note: A complete list of references is available from the publisher.

_about the author

cosmetic dentistry

Dr Jugoslav Jovanović is a researcher and lecturer in the field of laser-based oral applications and dentistry. As a member of several international organisations in laser-assisted dentistry, he has published numerous articles and has lectured at domestic and international congresses and workshops. He practises laser dentistry in his private practice in Kozarac (Bosnia and Herzegovina), where he focuses mainly on endodontics, periodontics, oral surgery and aesthetic dentistry.