An Overview of Bleaching Techniques: 3. In-Surgery or Power Bleaching

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Abstract: **The use of in-surgery bleaching techniques has increased recently within the profession following the introduction of various new systems. Many dentists and patients alike prefer the in-surgery procedures to lighten teeth as it takes the responsibility for the procedure firmly away from the patient to the dentist; a situation with which both sides may be more comfortable.**

This article will review various in-surgery or power bleaching procedures. In addition, it will detail the procedure involved and how and when to combine bleaching techniques.

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Clinical Relevance: **There are many power bleaching systems currently available to improve the appearance of teeth in the surgery.**

The concept of high concentration hydrogen peroxide used in-surgery to produce an almost immediate 'on the day' whitening result dates back to the early 1900s.[1] This was further modified in the 1990s with the introduction of gels, as opposed to liquids, applied to teeth using gauze squares. Other modifications included the replacement of high intensity light used as a heat source with conventional halogen units, plasma arc lamps, LED lights, Xe-halogen lights and lasers. Then as now, it is generally preferred by both dentists and patients that the responsibility for the procedure of lightening teeth is taken in-surgery. There are specific situations, such as single tooth bleaching within an arch, or even small areas on teeth that need to be lightened, where in-surgery or power bleaching is advocated. The dentist here has complete control throughout the procedure and is able to stop when the desired shade/effect is achieved. However, very often power bleaching can be used to give a kick start to the lightening process in order for the patient to see immediate results before being encouraged to comply with the home bleaching regimen. Power bleaching is thought to work by the permeation of oxygenating perhydroxyl free radicals through enamel micropores along a diffusion gradient and into the dentine where it oxidizes the stains and thereby bleaches the teeth. The free radicals are thought to attach to inorganic stain molecules and reduce or cleave double bonds of large organic molecules. Tooth whitening after a single power bleaching session using 35% HP has been shown to be effective in both clinical[2] and laboratory studies.[3,4,5] The indications/contra-indications of in-surgery bleaching were covered under the bleaching review in the first article, but specific mention should be given to areas of localized or developmental stains where in-surgery bleaching is indicated in order for complete control of the whitening process to be taken over by the clinician.

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ADVANTAGES OF POWER BLEACHING

The main advantages of the power bleaching technique are:

- The time factor – produces immediate results in-surgery which can be used to motivate the patient to continue with home bleaching top-up treatment.
- Avoiding problems with home bleaching procedures such as:
  - wearing trays that may cause patients to gag;
  - distaste for home bleaching gel.

Home bleaching is often reported by patients to give a metallic taste in the mouth which is thought to disappear within a couple of hours of removal of the trays from the mouth.

Figure 1. *Dehydration related shade change during power bleaching:* ***(a)*** *pre-bleaching shade C3;* ***(b)*** *shade immediately post bleaching procedure (A1); and* ***(c)*** *shade at two weeks post bleaching (A2).*

DISADVANTAGES OF POWER BLEACHING

Disadvantages of power bleaching include:

- The caustic nature of the 35–50% hydrogen peroxide makes isolation and protection mandatory;
- The increased surgery time required, making the procedure more expensive for the patient;
- Dehydration of the teeth may occur, thereby giving a falsely lighter shade immediately post treatment.[6]

This last factor can cause further problems with patients perceiving there is colour regression or rebound following re-hydration of the teeth (Figure 1). Some manufacturers have addressed this problem by producing gels that contain 10–20% water which re-hydrates the teeth throughout the bleaching procedure, while others have tackled the problem by using lower concentrations of hydrogen peroxide (15%), which is a water-based solution, thereby increasing the water content by 20%.

However, by far the biggest disadvantage of the power bleaching procedure is the caustic nature of the 35–50% hydrogen peroxide used. The need for a meticulous protocol in handling, applying, removal and disposal of these materials is essential.

SAFETY FACTORS IN POWER BLEACHING

Handling of hydrogen peroxide products to avoid the risk of tissue burns to the lips, cheeks, gingiva, the rest of the face or eyes makes isolation and protection techniques mandatory in the course of power bleaching.

The main safety issue concerning the activating lights used in power bleaching is heat generation and its effect on the pulp. Recent research showed the increase in the intra-pulpal temperature with most bleaching lamps was below the critical threshold of a 5.5 °C increase thought to produce irreversible damage. The only lamp that produced an intra-pulpal temperature increase above this threshold was the laser-based lamp and this was also found to be below the critical temperature once the power output was reduced from 3W to 2W.[7]

Most of the research on bleaching efficacy and safety has tended to concentrate on the use of home applied bleaching materials such as 10% carbamide peroxide[8] but, with the growth in popularity of in-surgery bleaching techniques, more work has been published on the use of 35% hydrogen peroxide for power bleaching procedures. The safety of 35% hydrogen peroxide for power bleaching has been extensively researched in a recent study which investigated the abrasion, erosion, hardness and structural changes on both enamel and dentine; the conclusion of the study was that 35% HP had no deleterious effects on either enamel or dentine.[8]

There are many different materials available but, broadly speaking, they are either based on 35% carbamide peroxide or hydrogen peroxide of the same or higher concentration. Hydrogen peroxide is more widely used as the power bleaching agent, but the range of concentrations in use today varies from about 17–50%; bleaching times also vary. Thirty-five percent carbamide peroxide yields approximately 10% hydrogen peroxide and is used in certain bleaching systems sometimes known as 'waiting room bleach', as the patient wears the custom-made trays full of the material and waits in the waiting room of the surgery. It is available in a powder/liquid combination mixed together to produce a gel or in a ready made gel to which liquid is added. There are many different combinations available depending on the system or activation method used. These bleaching materials will be discussed later in the article with the various activation systems available.

CASE SELECTION / BLEACHING PROTOCOL

Patients that present with decay, periapical lesions or have existing thermal sensitivity should be treated for these issues prior to the bleaching procedure. It is acceptable for decayed anterior teeth to have the decay excavated and dressed with a temporary glass ionomer filling material until two weeks after the bleaching treatment.

This will allow the clinician to shade match the permanent restoration to the new lighter tooth shade and also allow for enough time to elapse for dissipation of oxygen free radicals from the tooth which may otherwise compromise the composite bond to tooth.

Some authors advocate the use of full mouth periapical radiographs to document the size and vitality of pulps to predict sensitivity levels or check for periapical pathology[9]. In view of the current ionization radiation regulations and the unnecessary exposure of the patient to high levels of radiation, other forms of vitality testing such as ethyl chloride or electric pulp testers are advised instead. Any teeth that require root canal therapy should have this carried out prior to the bleaching procedure.

Patients should also be made aware that the procedure may need to be repeated or topped up with home bleaching to achieve optimal results, especially if the existing shade is dark or there's tetracycline staining.

Case selection and preparation of the patient for bleaching including diagnosis of the cause of discoloration were covered in the previous article on home bleaching. As in the previous article, special mention is again given to those patients with high expectations for the bleaching procedure who may never be satisfied with the results. Alternative treatments should be sort for these patients following establishment of their expectation level by asking a few pertinent questions. Only the actual operative procedure will be covered in this article.

Following the assessment of the teeth, the shade should be agreed with the patient and recorded in the notes. A pre-operative photograph with the shade tab *in situ* should always be taken under standardized lighting conditions without using the dental operating light which would washout the shade. After all the relevant explanations, options, limitations and prognosis have been discussed with the patient, a consent form should be signed and the patient should be referred for a hygiene session about a week to ten days prior to the bleaching procedure.

Operative Procedure

- Shade assessment on the day with the teeth wet and dry followed by photographs with shade tab *in situ*.
- External stain removal using a pumice/water slurry and a bristle brush or sodium bicarbonate with air abrasion units.
- Isolation: there are many forms of isolation that can be used, depending on the type of power bleaching procedure used, or the dentist's particular preference. Rubber dam is a good method of isolation used in combination with caulking putty beneath it on the gingival area. The teeth should also be ligated with waxed dental floss to prevent seepage of the fizzing hydrogen peroxide solution through to the underlying gingivae. Obviously, the use of rubber dam is contra-indicated when simultaneous dual arch power bleaching is used. Light bodied impression materials used in the past for isolation did not provide reliable protection and have been replaced by the newer paint on dam materials such as *Opal* dam (Ultradent Products, South Jordan, Utah, USA). These are light cured resin barrier materials that are painted on to the gingivae around and in between the teeth to be bleached (Figure 2). It is essential to ensure that the material covers a wide area of gingivae and mucosa around the teeth and flows interdentally so that it prevents leakage of the hydrogen peroxide to these areas. It may also be advisable to place the material lingually or palatally in interdental areas. The material can also be used to cover areas that are not intended for bleaching, such as exposed dentine caused by recession or developmental defects.

***Figure 2**. Isolation of teeth, gingivae and soft tissues: paint-on gingival dam extending from tooth margin across the gingivae into the interdental spaces and mucosa. Cheek and tongue retractor keeps soft tissues away from the bleaching gel.*

- Soft tissue retraction: cheek and lip retractors are placed to pull these tissues away from the teeth and bleaching gel. There are many products available, some of which have inbuilt suction facility (NOLA Full Arch isolation, Orthocare-UK) which is very useful, while others have a tongue guard to prevent the forward movement of the tongue on to the teeth and bleaching gel. Further tissue protection is provided by gauze and cotton wool rolls placed inside the lips and cheeks to keep them away from the gel. Vaseline should be used on the lips to reduce cracking of the lips and prevent them from drying up. A low volume saliva ejector should be placed at the back of the patient's mouth and the dental chair should be adjusted to allow the patient to swallow comfortably any saliva that is not removed.
- Bleaching cycle: power bleaching products would normally be refrigerated and should therefore be allowed to reach room temperature for at least an hour prior to the procedure or be activated by running the syringe under warm water for a few minutes. A fresh mix of gel is mandatory as these products have

Figure 3. *Power bleaching gel applied to teeth on both arches in the smile zone to a depth of approximately 2–3 mm layer. The gel is slightly lipped across the incisal edge and palatal/lingual surface in cases where there is no incisal wear and only if a tongue guard is present on the cheek retractor to prevent inadvertent tongue protrusion causing soft tissue damage.*

Figure 4*. Soft tissue damage with the use of 35% hydrogen peroxide: gingival blanching around the lower right canine and first premolar as a result of the peroxide free radicals seeping under the gingival barrier protection. This is not necessarily painful to the patient but should be treated with copious amounts of water and then the placement of a neutralizer cream usually provided in the bleaching kit.*

a very short active time before which the free radicals are depleted; any gel remaining should be disposed of after use. The consistency of some preparations can be altered by varying the hydrogen peroxide liquid content but generally the mix should be creamy and slightly spreadable, similar to that of acid etch gel, so that it can be easily applied using a brush or plastic spatula.

- A 2–3 mm layer of freshly mixed gel should be applied to all the labial surfaces of teeth in the smile zone and lipped over to cover the incisal edges and extend slightly lingually or palatally (Figure 3). This should only be done in the absence of exposed dentine caused by incisal wear. The smile zone varies between patients but is commonly from the first or second premolar to its contra-lateral counterpart.
- Activation with or without a light source depends on the bleaching system used.
- The gel is left in place for a length of time dependent on the system and concentration of hydrogen peroxide used, usually about 10 minutes, but can range from 3–20 minutes at a time.
- The gel is suctioned off the teeth using high volume suction and the teeth wiped using damp gauze before being lightly dried.
- A further fresh mix of gel is now applied to the teeth, activated as before and left in place for the same length of time. After removal of the gel using suction, the teeth are washed with copious amounts of water before light drying. The application and activation procedure is repeated one more time before final washing and drying of the teeth. Therefore contact of the bleaching agent with the teeth is for three 10-minute cycles, often known as passes. Hence, power bleaching procedures usually involve three 10-minute passes, but some systems use three or four 20-minute passes with lower concentrations of hydrogen peroxide, while others use 3-minute passes repeated five times with total bleaching time being 15 minutes.
- After removal of the isolation dam the gingivae and surrounding mucosa are examined for blanching or areas of redness indicating hydrogen peroxide seepage through the isolation (Figure 4). Areas of damage should be thoroughly washed with copious amounts of water before the application of a neutralizing agent, such as vitamin E, usually supplied within the bleaching kits.
- Polishing with a diamond polishing paste gives a high lustre look to the teeth and further enhances the appearance of the teeth.
- Application of a neutral colourless fluoride gel such as *Gelkam* (Colgate-Palmolive Limited, Guildford, UK) may help in cases where there was sensitivity experienced during the procedure.
- Final shade assessment and post-operative photographs should be taken with both start and final shade tabs *in situ*.
- Patients should be given post-operative instructions. These include:
  - The use of a fluoride gel or potassium nitrate containing toothpaste in cases that experience thermal sensitivity.
  - Dietary advice to avoid acidic drinks, fruits, tea, coffee and smoking for 48 hours. It is thought that the oxidizing free radicals are still active within the teeth for a further 48 hours post bleaching.
  - Shade regression of about half a shade unit tends to occur about a week to ten days post bleaching. Patients should be made aware of this to avoid disappointment.
- Top up home bleaching kits should be given to those cases that require further bleaching.

CURING LIGHTS

Various types of curing lights are used to activate the bleaching gel or expedite the whitening effect. Initially, conventional curing lights were used but these were quickly joined by lasers and plasma arc lamps. In addition, some systems are activated by a chemical reaction on mixing two gels, while others utilize a dual activation system.

Halogen Curing Lights

Curing lights such as *Demetron 501*

(Kerr Dental Ltd, Peterborough, UK) can be used with a number of different systems such as *Polar Office* (SDI, Victoria 3153, Australia) or *Quick White Net* (DMDS UK, Canterbury, UK). Activation is via the light's bleach mode for 30 sec per tooth and, generally, the application involves three 10-minute passes. Some products available, such as *Opalescence Xtra* (Ultradent Products, South Jordan, Utah, USA) are based on a pre-mixed 35% hydrogen peroxide gel that contains carotene which converts light energy to heat and therefore increases the activation of the hydrogen peroxide by encouraging further breakdown into active free radicals.

Plasma Arc Lamp

Systems that use these lights are usually based on three 10-minute passes with light activation in whitening mode for 3 sec per tooth performed twice during the pass. Alternatively, a full smile adaptor is used to illuminate both arches together for the full 10-minute pass with the light switching on and off in 5-sec bursts but giving out lower intensity.

Xe-Halogen Technology

These systems utilize a full smile illuminator placed a few centimetres in front of both arches to activate 35% hydrogen peroxide gel with the usual protocol being three 10-minute passes

***Figure 5**. Xe-Halogen light (Luma Arch, DMDS UK, Canterbury UK) used in dual-arch activation of the power bleaching gel. The light is placed a few centimetres in front of both arches and is usually applied in three 10-minute passes.*

***Figure 6.** Diode laser (830 nm, Velopex Diode, Medivance Instruments Ltd, London, UK) in use activating the bleaching gel in 30-second bursts per tooth with the gel left* in situ *for ten minutes. The procedure is repeated for a further two 10-minute applications.*

(Figure 5). However, some authors have recommended the use of a combination of carbamide peroxide (22%) and hydrogen peroxide (38%) for 20-minute passes repeated three times, but this protocol must be questioned in terms of possible penetration into the pulp chamber and whether there is any benefit in combining 22% carbamide peroxide, which breaks down into approximately 7.5% hydrogen peroxide.

Diode Lasers

Both 830 nm and 980 nm wavelength diode lasers can be used for tooth bleaching in combination with 35–50% hydrogen peroxide gel. The gel is produced by mixing the hydrogen peroxide liquid with a powder mainly containing fumed silica and a blue dye. The blue dye absorbs the laser wavelength and heats up to cause the controlled breakdown of the hydrogen peroxide to oxidizing perhydroxyl free radicals.

The system is also based on applying 2–3 mm of gel to teeth in the smile zone and three 10-minute passes with activation using 1–2 W of laser energy for 30 sec per tooth (Figure 6). It is essential that all present, including the dentist, patient and nurse are correctly protected with eye protective glasses as ocular damage is a real risk with the use of these lasers.

Metal Halide Lamp

The *Zoom* light (Discus Dental, Culver City, CA 90232, USA) is used with a two part 25% hydrogen peroxide gel in a dual arch technique employing three 20-minute passes followed by the application of sodium fluoride gel.

CHEMICAL ACTIVATION

Systems such as *Opalescence Xtra-Boost* (Ultradent Products, South Jordan, Utah, USA) are based on 38% hydrogen peroxide two part gel system. It consists of one syringe, containing hydrogen peroxide, that is chemically activated by mixing with the second syringe, containing a unique proprietary activator that increases the pH to 7 for maximum activation. When mixed together, a supercharged bleaching agent is produced that does not require light activation.

DUAL ACTIVATED SYSTEMS

Hi Lite (Shofu Dental Products, Tonbridge, Kent, UK) is a system that contains both ferrous and manganese sulphate which are chemically and light activated, respectively, to accelerate the bleaching process to 7–9 minutes.[9] The system is based on 35% hydrogen peroxide blue gel that is activated using a conventional light curing unit. After about 2 minutes, the gel changes colour to green, following oxidization, and then to cream, before finally becoming chalky coloured on complete inactivation. At this point it is removed and a fresh mix is applied, with the procedure being repeated up to six times in one session.

WAITING ROOM BLEACH TECHNIQUE

Thirty-five percent carbamide peroxide is activated by holding the syringe under hot running water for a few minutes prior to use. The gel is placed in the custom-made tray, which is then put in the mouth of the patient where the

excess material is removed. The patient is then asked to sit in the waiting room for about 30 minutes to an hour. After this time has elapsed, the patient returns and the gel is suctioned and rinsed off the teeth. The procedure can be repeated 2–3 times more in the one session.

COMPRESSIVE BLEACHING TECHNIQUE

This technique, reported by Miara,[10] suggests that the power bleaching technique can be made more effective by compressing the gel against the teeth. This is based on the observation that, on decomposition of the power bleaching gel, small bubbles appear in the gel that indicate the release of oxygen ions and, unlike in home bleaching techniques, these ions migrate and a small proportion of them will permeate the enamel. In order to enable the permeation of oxidizing ions through the enamel, the nascent oxygen must be guided under pressure.[10]

The procedure involves the usual isolation and placement of 35% hydrogen peroxide gel, such as *Opalescence Xtra*, in a custom-made tray, which is put in place and any excess material is removed before the lingual and buccal edges of the tray are sealed with light cured resin material, to prevent any leakage during gel decomposition. Once the edges are sealed, the gel is activated using either a halogen light or a plasma arc lamp. After 30 minutes, the gel and isolation are removed and the teeth are washed, with the procedure being repeated on another occasion, using home bleaching with 10% carbamide peroxide in the interim for maximum results. This technique is relatively new and is undergoing clinical evaluation. Concerns with this technique include the probable penetration of hydrogen peroxide into the pulp chamber after only 15–20 minutes.[11] In addition, there is no proof that the presence of the tray will force the nascent oxygen back into the tooth to enhance the bleaching procedure as hypothesized.

COMBINING BLEACHING TECHNIQUES

Combining different bleaching techniques serves a number of purposes including improving the effectiveness of the whitening procedure, especially when there are stains of varying aetiology or cases of tetracycline staining. It is also used to motivate those patients whose compliance levels for home bleaching is questionable. The patient is encouraged by the almost immediate results produced by power bleaching to continue with top-up home treatment to achieve maximum whitening results. It is also desirable to combine techniques in cases where a non-vital tooth is involved or single teeth with multiple stains.

ULTRASONIC TECHNOLOGY

The latest addition to in-surgery bleaching systems is the *SoniWhite Whitening System* (DMDS UK, Canterbury, UK) which utilizes ultrasonic technology with a 6–7.5% hydrogen peroxide gel in upper and lower trays. The procedure only involves approximately two cycles of 5 minutes but it is thought that the use of the ultrasonic energy indirectly encourages the production of more oxygen-free radicals that permeate through the tooth to produce the whitening effect.

CONCLUSION

Power bleaching may frequently require more than one visit to produce an optimal result. However, for many patients a single visit is enough to satisfy their aesthetic needs and no further treatment is required. Power bleaching should be used in cases where time is at a premium, with patients requiring faster results, and cases where it is felt the patient needs a 'kick start' before continuing with home bleaching. It can also be used on teeth with different stain aetiologies, but must be carried out with meticulous care and attention owing to the caustic nature of the 35% hydrogen peroxide used.

The goal of modern dentistry is maximum preservation of tooth substance with excellent aesthetics. Bleaching alone or in combination with minimally invasive adhesive dentistry fulfils this goal very often without the need to progress to the much more destructive techniques of veneers, crowns and bridges.

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