REVIEW ARTICLE

Bleaching in the Clinical Practice of Dentistry: An Overview

Devendra Chaudhary, Deepti Pupneja and Nikhil Sibal

ABSTRACT

Aim: One of the most frequent reasons an individual seeks dental care is discolored anterior teeth. Treatment options include removal of surface stains, bleaching, microabrasion, macroabrasion, veneering and placement of porcelain crowns. The aim of this article was to examine the research articles regarding tooth bleaching.

Summary: Bleaching has been reported to be now the single most common esthetic treatment for adults. In the beginning of the twentieth century, bleaching of teeth was considered a provocative, experimental modality. With the advent of newer bleaching tehniques, tooth bleaching has now been considered as single most common aesthetic treatment modalities for adults that provides a conservative solution for mild to moderate discolored vital or root filled teeth. This review encompasses the various aspects in development, present stage clinical scenario and emphasises on future advances especially power bleaching, plasma-arc light bleaching and Laser activated bleaching in the domain of dental bleaching.

Keywords: Bleaching agents, Hydrogen peroxide, Tooth bleaching, Tooth discoloration

INTRODUCTION

The presence of noticeable discoloration of teeth can be a physical handicap that can impact upon a person's self-image, self-confidence, physical attractiveness and employability.[1]

Prof. Devendra Chaudhary completed his graduation (BDS) in 1992 and postgraduation (MDS) in the subject of Conservative Dentistry and Endodontics in 1995 from Faculty of Dental Sciences, King George Medical College, Lucknow, India. Since then he is in academics and working as PG teacher for last 13 years.

Department of Conservative Dentistry & Endodontics, MM College of Research & Dental Sciences, MM University, Mullana, Ambala, India.

Address for Correspondence:
Dr Devendra Chaudhary, 1633 – Sector 17, HUDA, Jagadhri 135003, Yamunagar (Haryana). Contact : +919991100777,
E-mail: hellodrdc@yahoo.com
Date of Submission : 27-09-2011
Reviews Completed : 29-09-2011
Date of Acceptance : 07-10-2011

A study assessing the impact of teeth on personal aesthetic satisfaction found that dental variables (including tooth color) were more important than orthodontic variables, suggesting that the appearance of the teeth was a greater contributing factor to an aesthetic smile than their position within the arch.[2] One of the most frequent reasons patient's seek dental care is discolored anterior teeth. Treatment options include the removal of surface stains, bleaching, microabrasion, macroabrasion, veneering and placement of porcelain crowns, and amongst them, bleaching of teeth are the single most common aesthetic treatment for adults.[3] It is estimated that more than a million people have had their teeth bleached by dentists, while perhaps millions more have tried their own hand at beaching with over the counter products. Bleaching is the simplest, least invasive, inexpensive means available to lighten the color of teeth and diminish or eliminate many stains in both vital and non-vital teeth for the appropriate patient, with careful diagnosis, case selection, treatment planning and attention to technique. Grossman[4] has described bleaching as a procedure in the restorations of normal color to a tooth by decolorizing the stain with a powerful oxidizing or reducing agent. This review examines the various aspects in development and present stage clinical scenario with major emphasis on future advances in the domain of dental bleaching.

METHODS

The PubMed database was primarily searched in the period of January 1st, 1980 to January 1st, 2011 and MeSH words used were "tooth bleaching" and "bleaching agents". Publications were limited to English. The authors examined the abstracts of the pertinent articles. Relevant articles were included, and further a secondary search was conducted by hand-search through the cross-references of included articles. Relavent literature in common textbooks, bibliographies of papers and review articles of suitable peer reviewed journals were also analyzed for additional information.

LITERATURE REVIEW

A professional response to the inexorable pursuit for whiter teeth dates back at least 2000 years and it was found that in the 1300's tooth whitening was the most requested dental service, other than extraction. After abrading the enamel with coarse metal files, barber-surgeons would apply "Aquatortis" a nitric acid solution, to whiten the teeth.[5] Since then, there

has been a great deal of evolution in the bleaching, tooth whitening materials and techiniques (Table-1).[5-14] Recently we have seen the introduction of an alternative method to facilitate absorption of the bleaching agent by applying a weaker bleaching solution for longer periods, usually by placing it in a retainer like matrix worn by the patient for extended periods. Bleaching is now moving into a new phase of development. In its first phase at the turn of the twentieth century, bleaching of teeth was a rather provocative, experimental modality. In its second phase, despite the fact that dentists recognized its effectiveness and safety in the middle of this century, bleaching was usually seen as a last ditch effort to correct a particular type of discoloration, performed on highly selected patients by a few pioneering dentists. In its third phase, bleaching became more acceptable as an effective and safe in office treatment for a wider spectrum of cases. Today in the fourth and doubtless not yet the final phase, in-office and matrix bleaching and procedures such as power bleaching, plasma-arc light bleaching and Laser activated bleaching are being efficiently performed.

Tooth Discolorations: Knowledge of the aetiology of tooth staining is of paramount importance in order to enable the correct diagnosis, prognosis and treatment planning. It also allows the dental practitioner to explain to the patient the exact nature of the condition. The discoloration of the teeth is often influenced by a combination of their intrinsic colour and the presence of any extrinsic stains that may form on the tooth surface. *Extrinsic* discoloration arises due to external chromogens that are deposited on the tooth surface or within the pellicle layer.[3] Extrinsic stains may occur due to *direct* staining by the compounds incorporated into the pellicle layer and producing a stain as a result of the basic color of the chromogens or *indirect* staining due to chemical interaction at the tooth surface with another compound. Direct-staining chromogens are derived from dietary sources such as tea and coffee. Polyphenolic compounds found in food are thought to give rise to the color of the stain. Besides this, direct staining may also arise from smoking or chewing tobacco, medicines, spices, vegetables and red wine. Indirect dental stains associated with cationic antiseptics and metal salts that are either colorless or a different color from the stain produced as a result of a chemical interaction with another compound.[15] Chromogens, often of systemic or pulpal origin, when are deposited within the bulk of the tooth (usually in the dentine) results in *intrinsic* discoloration.[3] Intrinsic discoloration occurs during tooth development, and results in an alteration of the light transmitting properties of the tooth structure which include metabolic causes, inherited causes, iatrogenic causes, traumatic causes, idiopathic and ageing causes. *Stain internalization* are another types of stains that include those circumstances where extrinsic stain enters the tooth through defects in the tooth structure[3,15] for example orange to brown discoloration due to caries and brown, grey or black discoloration due to restorations.[15]

Table 1: Evolving history of bleaching (From Greenwall L. Bleaching Techniques in Restorative Dentistry. An Illustrated Guide. 1st ed, Martin Dunitz Ltd, 2001)

Year	Bleaching material/ techniques
1799	Macintosh developed chloride of lime and called it *bleaching powder*.
1884	Harlan reported the first use of hydrogen peroxide called hydrogen dioxide.[6]
1895	The bleaching of nonvital teeth was first mentioned by Garretson, who used chlorine as the bleaching agent.[6]
1916	Hydrochloric acid was used successfully to treat "Colorado brown stain." [6]
1918	Abbot discovered what remains the basic combination used today – a high intensity light that produces a rapid rise in temperature of the H_2O_2 to accelerate the chemical process of bleaching.[7]
1937	The combination of five parts of 100% H_2O_2 with one part of ether and heat was reported as a treatment for this same type of discoloration.[7]
1939	Successful bleaching of fluorosis staining using 30% H_2O_2, ether and heat was described.[7]
1958	Pearson[8] realized the dentist could take advantage of the non vital tooth's lack of pulp. He packed the same H_2O_2 agent being used for bleaching of vital teeth, in the pulp chamber for 3 days.
1961	Spasser described a method of sealing a mixture of sodium perborate with water into the pulp chamber and leaving it in situ for 1 week. (walking bleach technique).[9]
1965	Bouschar[10] reported the use of 5 parts 30% hydrogen peroxide, 5 parts 36% hydrochloric acid, 1 part diethyl ether for treatment of orange fluorosis stains.
1965	Thermocatalytic technique Pellet saturated with superoxyl inserted into pulp chamber and heated with hot instrument was utilized by Stewart.[11]
1966	McInnes in 1966 repeated Bouschar's technique using controlled HCl – pumice abrasion technique.[12]
1984	Ultraviolet rays were also tried for bleaching of vital teeth.[5]
1996	Laser tooth whitening.[13]
1997	A new technique, using the open pulp chamber and 10% carbamide peroxide in a custom tray, has been recommended – 'inside/outside technique'[14]

Chemistry of Bleaching: The three most prominent commercial bleaching materials are peroxide, chlorine and chloride, in that order. Peroxide bleaching requires the least time and is most commonly used. Although bleaching processes are complex, the vast majority works by oxidation, the chemical process by which organic materials are converted into carbon dioxide (CO_2) and water (H_2O). Bleaching slowly converts organic materials into chemical intermediates that are lighter in color than the original.

In dental bleaching, hydrogen peroxide H_2O_2 (alone or obtained from carbamide peroxide) diffuses through the organic matrix of the enamel and dentin.[16] Since the radicals have unpaired electrons, they are extremely electrophilic and unstable and will attach most other organic molecules to achieve stability, generating other radicals. These radicals can react with most unsaturated bonds, resulting in disruption of electron conjugation and a change in the absorption energy of the organic molecules in tooth enamel. Simpler molecules that reflect less light are formed, creating a successful whitening action. This process occurs when the oxidizing agent reacts with organic material in the spaces between the inorganic components within the tooth enamel (Fig. 1). The extent of bleaching determines the amount of whitening compared to the amount of material loss. During the initial bleaching process highly pigmented carbon-ring compounds are opened and converted into chains, which are lighter in color and exemplifies the existing hydroxyl group

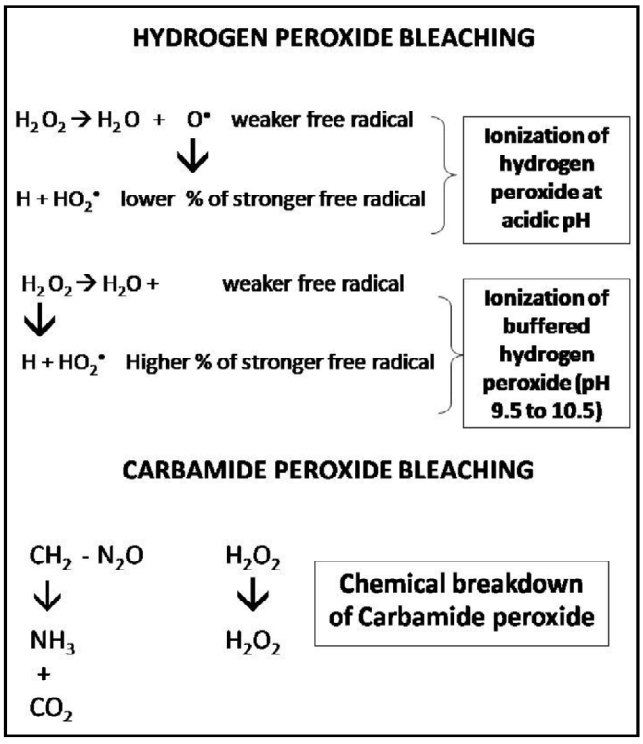

Figure 1: Depicts the reaction for hydrogen peroxide and carbamide peroxide bleaching.

(alcohol like), which are usually colorless. As these processes continue the bleached material continually lightens.[17]

Bleaching Agents: In last two centuries, numerous materials for bleaching have been evolved. 10% aqueous solution of Carbamide peroxide is the most common ingredient in the home bleaching kits that breaks down to a 3.35% solution of hydrogen peroxide and 6.65% solution of urea, whereas, for the supervised home bleaching procedure, 15% (yields 5.4% hydrogen peroxide) and 20% solutions of carbamide peroxide (yields 7% hydrogen peroxide) are also available.[7,18] Most of the bleaching agents contain some form of hydrogen peroxide that breaks down into water and oxygen, and this released oxygen molecules penetrate the tooth and liberate the pigment molecules causing the tooth to whiten.[7,19]

Non-hydrogen peroxide containing materials contain sodium perborate as the active ingredient, but also reported to contain Hydroxylite™ sodium chloride, oxygen and sodium fluoride and other raw materials. It does not contain or produce hydrogen peroxide and liberate a negligible amount of free radicals unlike the 10% carbamide peroxide gel.[7]

Novel Tooth Whitening Systems: Whitening strips and Whitening gels are two groups of novel tooth whitening systems. The former are used to apply the product directly to the teeth and the latter are itself applied directly to teeth. Crest whitening strips (Proctor and Gamble, USA) were introduced in 2000, are flexible, polyethylene bleaching strips that are designed to deliver Hydrogen Peroxide (HP) (6%, 6.5%, 10% and 14%, depending on brand type) in an adhesive gel form directly to the labial surface of anterior teeth. Strips are shaped to allow for ease of adaptation to upper and lower anterior teeth after tooth brushing. Whitestrips should be worn only during waking hours and not during sleeping, smoking or eating. Best protocol for application is 30 minutes twice daily for 14 days. Whitestrips premium have a higher level of peroxide and claim results only in seven days.[20] Simply white (Colgate, USA), a novel, topically applied tooth bleaching system contains 18% and 16.4% carbamide peroxide. They release 6.03% and 5.28% HP respectively. The gel is applied with a special applicator to the labial surface of the teeth to be treated. After drying the teeth, the agent is applied twice daily for 2 weeks. Crest Night Effects contains 19% sodium perborate and has been shown to effect a stable color change. Mentadent Xtra White (Unilever Oral Care, Port Sunlight, UK) contains 6% HP supplied in a jar and a set of 30 applicators, which are similar in appearance to cotton buds. The gel is applied after brushing twice a day. The applicator is discarded after use, which the manufacturers state will reduce microbial contamination and possible peroxide inactivation caused by applicator re-use.

Whitening toothpastesare very effective in removing extrinsic stains, which can improve the overall appearance of teeth but

not the underlying color, which is directly related to the color of underlying dentin. Post bleaching, whitening toothpastes do have a place in reducing and preventing the buildup of extrinsic stains, but their value in maintaining bleaching teeth is doubtful. More aggressive powders and toothpastes advocated for smokers are considerably abrasive and not to be recommended.[20]

Recently introduced, Dual–chambered technologies (e.g. Simply White toothpaste) have enabled Hydrogen peroxide (HP) to be added to dentrifrices. The product is expressed as separate entities, mixing only on the brush. This stabilizes the peroxide component providing approximately 1% hydrogen peroxide. Initial studies suggest that these pastes have considerable promise, with reductions in staining and lighter teeth reported when compared to a regular whitening paste.

Effect of these novel tooth whitening systems is affected by age, with a 0.3% reduction in whitening benefit recorded for each 10 years of ageing. This is probably due to the fact that these systems have a reduced effect on darker teeth, which are more likely when the effects of age-related discoloration are considered. Joiner *et al.*[21] conducted a study to evaluate the in vitro tooth whitening effects of a novel, 6% HP containing tooth whitener Xtra White (XW) on extrinsic and intrinsic tooth color and the effects on enamel and dentin microhardness. In addition, to determine the levels of peroxide found in tooth pulp chambers after treatment with XW in vitro. The study showed XW to be an effective tooth whitening product *in vitro* with support for its safety on subsurface enamel and dentin together with its safety on tooth pulp tissue.[21]

Power Bleaching: 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. This was further modified in the 1990s with the introduction of gels which provided better manipulation of the agent, as opposed to liquids when 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, and lasers.[22,23] 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.[24] 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% Hydrogen Peroxide has been shown to be effective in both clinical and laboratory studies.[22,23]

Gultz *et al.*[25] analyzed the effects of heated and light absorbing bleaching agents on tooth surface morphology. 12 freshly extracted human anterior teeth were treated with Opalescence (a heated bleaching agent), Opalescence Xtra (a light absorbing bleaching agent) and with 35% phosphoric acid. This study indicated that no differences in enamel surface morphology were observed between the untreated control group and with either the 35% carbamide peroxide bleach or 35% hydrogen peroxide light activated bleaching material. The group etched with phosphoric acid showed a significant difference in enamel surface morphology when compared to other groups.[25]

The use of a gel for in office bleaching decreases the incidence of tooth sensitivity by reducing the tooth desiccation commonly observed with the liquid and the liquid/powder products. The gel contains 10-20% water which rehydrates the tooth as bleaching continues. The consistency of the gel allows it to remain in intimate contact with the tooth.[26] The presence of water in the gel reduces the shelf-life and some of these products need mandatory refrigeration.[27] The gels minimize the possibility of soft tissue contact as they remain in the area where they are placed. With regard to tissue protection, the standard rubber dam with mucosal protector can be used; also many light-activated liquid resins are available to protect the gingiva, which have gained popularity (Paint-on- Dam by Den-Mat Corporation and Opaldam by Ultra dent, USA). The energizing activating source could be the traditional bleaching light, regular halogen curing light, the newer Plasma arc light Argon and CO_2 lasers, Xenon power arc light and the Diode laser. Tavares *et al.*[28] reported that peroxide and light treatment significantly lightened the color of teeth to a greater extent than did peroxide or light alone, with a low transient incidence of tooth sensitivity.

A recent study demonstrated that 38% H_2O_2 applied for a total of 90 minutes (three 30 minute applications), resulted in nine shade changes with a two shade rebound after 7 days).[29] This degree of shade change has been replicated in other trials, although the degree of relapse does differ. Color stabilization of power bleached teeth is generally seen within 6 weeks. An interesting use of power bleach is its application to fluorotic teeth, where it has been shown to bleach non-fluorotic areas, resulting in a more uniform appearance.[30] It means that one can just power bleach the entire tooth surface to achieve a uniform shade rather than bleaching the individual fluorotic spots which shall lead to a color mismatch.

Combination of Power and Home bleaching treatments: This approach is commonly used to motivate the patients to comply with the home bleaching protocol and continue bleaching at home. Normally one or two power bleach in-office sessions are undertaken. The patient is then given the home bleaching instructions, the tray and enough material to continue bleaching at home. The advantages of this technique are that it eliminates the tedium of repeated office visits and rubber dam applications. The procedure can be adapted to suit the

patient's bleaching needs, requirements and lifestyle. Power bleaching provides a 'jump start' and demonstrates some improvement while the tray is being made.[14]

Inside/outside combined bleaching technique: The inside/outside bleaching technique has also been called 'internal/external bleaching' as originally described by Settembrini *et al*.[14] and is the modification of the technique 'patient-administered intracoronal bleaching technique' or 'modified walking bleach technique'.[31] The technique combines the intracoronal bleaching technique with the home bleaching technique. It is used to lighten non-vital teeth in a simple manner. After barrier placement, the access cavity is left open so that the bleaching material which is normally 10% carbamide peroxide can be placed into the pulp chamber while the bleaching tray is applied to the tooth to retain the material on the tooth. Bleaching can thus take place internally and externally at the same time. This technique is a modification of the intracoronal bleaching technique

Assisted bleach technique or waiting room bleach technique: This bleaching technique can be used for both vital and non-vital teeth. It was invented by Den-Mat when the Quick-Start product was introduced to be used to initiate the bleaching procedure and for the patient to continue bleaching at home. The 35% carbamide peroxide (which breaks down to 10% hydrogen peroxide) is marketed as a power bleaching agent. The teeth are polished with prophylaxis paste. Cheek and lip retractors are placed. The 35% Carbamide peroxide can also be heated gently, by holding the syringe under hot running water for 2-3 minutes, prior to use, but this is not mandatory.[32]

The heating of the syringe accelerates the activity of the material before it is loaded into the mouth guard.[33] The dentist applies the 35% carbamide peroxide into a custom-made bleaching tray. After the excess material is removed, the patient returns to the waiting room for a period of about 30 minutes with the bleaching tray in the mouth. The patient can remain in the operatory during this time. After 30 minutes, the bleach is suctioned off the teeth before rinsing. Each tooth is then rinsed keeping the high volume evacuator on the tooth that is being rinsed. The procedure can be repeated 2 -3 times more in one session.[33]

Compressive bleaching technique: This technique, reported by Miara,[34] 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 indicates the release of Oxygen ions and, unlike in home bleaching techniques, these ions migrate and a small proportion of them will penetrate the enamel. In order to enable the permeation of oxidizing ions through the enamel, the nascent oxygen must be guided under pressure.[34] The procedure involves the usual isolation and placement of 35 % hydrogen peroxide gel 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 decomposition. Once edges are sealed, the gel is activated using either a halogen light or plasma arc, after 30 minutes the gel and isolation are removed and teeth are washed

This technique is new and undergoing clinical evaluation. The concerns with this technique include probable penetration of the bleaching agent into the pulp chamber after only 15-20 minutes. In addition there is no proof that the presence of tray will force the nascent oxygen back into the tooth to enhance the bleaching procedure as hypothesized.[34]

In-office dual-activated technique: The Hi-Lite in-office bleaching system is formulated for both light and chemical activation. It includes ferrous sulphate, which serves as a chemical activator that completes the bleaching process in 7-9 minutes. In addition, the formulation includes manganese sulphate, which is light activated and can accelerate the bleaching process to as little as 2-4 minutes. This technique uses hydrogen peroxide in a strong concentration of 19-35%. A feature of the Hi-Lite material (Shofu) is that it has blue-green indicator dye which starts off as blue and as it becomes deactivated changes to white. This helps the dentist to minimize the amount of time the bleach is kept on the teeth and maximize the results.[35,36]

Self Activating Bleaching Agent for Vital Teeth: For the bleaching of discoloured vital teeth, 30 – 35 % H_2O_2 is popularly used and activated with heat of light or a heated instrument.Because of heat and glare, patients feel uncomfortable during the bleaching procedure. Matsuba *et al*.[37] reported a new method of activating H_2O_2 without any unpleasantness. The chemical reaction of liberation of radicals occurs immediately after mixing H_2O_2 with CaO. The reaction time and oxygen volume liberated from H_2O_2 are related to the particle size of CaO. When the particle size of CaO is larger, the reaction time is longer and the oxygen volume is smaller.[37]

Ultrasonic technology: The latest addition to in office bleaching systems is the SONI whitening systems which utilize ultrasonic technology with a 6-7.5 % hydrogen peroxide gel in upper and lower trays. The procedure involves approximately two cycles of 5 minutes but it is thought that use of ultrasonic energy indirectly encourages the production of more oxygen free radicals that permeate through the tooth to produce whitening effect.[38]

Laser activated bleaching: Dental lasers were introduced and recognized as a tool for better patient care in the early 1990's.[39-41] In the ensuing years, clinicians have found that practicing cosmetic dentistry can be more exciting and rewarding by using laser technology for accomplishing the general and cosmetic tasks.[30] Clinicians in this specialized area seek to provide the highest caliber of care, while enhancing the

esthetics of the smile. The objective of laser bleaching is to achieve the ultimate power bleaching process, using the most efficient energy source, while avoiding any adverse effects. Using the 488 nm Argon laser as an energy source to excite the hydrogen peroxide molecule offers more advantages than other heating instruments.[42]

The latest development of power bleaching has offered easy-to-use bleaching agents, essentially using highly concentrated hydrogen peroxide mixed with thickening agents or additional buffering agents, catalysts, or coloring agents. The Food and Drug Administration (FDA) have cleared three dental laser wavelengths for tooth whitening: Argon, CO_2 and the most recent 980 mm GaAIAs diode.[43] Feinman *et al*.[44] treatment concept for laser bleaching involves the mixture of 50% hydrogen peroxide in a sodium perborate, proprietary power base. Argon laser energy is used first to remove deep-colored stains, followed by a CO_2 laser, which emits the mid-infrared thermal energy that is absorbed rapidly by water and the moist bleaching paste. The bleaching paste is applied several times; the teeth are then cleaned, followed by a final coating of fluoride gel. The CO_2 laser then is activated to promote the remineralization of the tooth surface. Caution should be exercised when using the CO_2 laser because the characteristic of this wavelength is thermal and well absorbed into water and hydroxyapatite.[43]

Similar to the argon laser, the *plasma-arc lamp* can provide the high (>1000 mW/cm2) to medium (>500m W/cm2) intensity of light. The Apollo plasma arc lamp emits a high intensity (> 1000 mW/cm2) for 3 second curing cycles; for bleaching cycles, at 820 n W/cm2. The goal of this type of activation in power bleaching is to whiten with efficiency, by obtaining controlled temperature elevation of the hydrogen peroxide on the tooth surface or by dumping high-energy photons to pump the hydrogen peroxide molecules up to the high vibrational eigenstate of the bleaching agents. The latter accelerates the chemical redox (reduction and oxidation processes occur simultaneously) actions of the bleaching process applied to the tooth surface but with no adverse pulpal effects.[45] Currently the argon laser has proved to be the most valuable energy source for power bleaching. Clinicians need to learn more about constantly updated technology and apply newly discovered methods and protocols to benefit patients and clinicians.

The expeditious rate of reaction in laser bleaching makes one major beneficial difference when compared with other methods of bleaching. Enough research has been concluded to assure clinicians that laser bleaching using the argon laser as an energy source with the highly concentrated H_2O_2 is the most efficient method in the tooth whitening process. These two components: the ideal energy source and high concentration of the bleaching gel: meet all the criteria required for achieving the ultimate rate of reaction.

More research is needed to streamline, simplify and shorten the already short whitening time and to be able to achieve predictable shade changes to match the color of existing teeth and restorations.[46,47] Until that time, this new technique enables dentists to give patients one more choice in their pursuit of whiter teeth in an easily attainable, single appointment.

DISCUSSION AND CONCLUDING REMARKS

With the advent of newer bleaching tehniques, tooth bleaching has now been considered as single most common aesthetic treatment modalities for adults that provides a conservative solution for mild to moderate discolored vital or root filled teeth. Additionally, over-the-counter availability and market gimics by the manufactures of the tooth whitening agents have resulted in an indiscriminate use of bleaching techniques. Hence proper diagnosis of the cause of the discoloration should be made and recorded in the patient's notes and all the options for treatment that can be extrinsic stain removal, bleaching or both, or veneers and crowns, should also be discussed with the patient.

Most of studies related to the safety of bleaching agents that concentrate mainly on the use of carbamide peroxide used in at home bleaching systems have suggested bleaching to be a relatively safe procedure, but potential structural changes that may occur as a result of bleaching have put some doubts.[15] Adverse effects reported by all home bleaching products incude an unpleasant taste, burning palate sensation, burning throat or gingival tissues, gingival ulceration and tooth sensitivity,[48] that usually resolve on cessation of treatment.[15]

The issue relating to carcinogenicity of hydrogen peroxide has been appearing periodically in literature and remains a controversial subject till date. Most studies found no evidence of carcinogenicity of hydrogen peroxide, whereas other found it to be carcinogenic.[49] Hence, future research is encouraged to clarify the controversy and concerns in this regard. Similarly overall data available so far show that hydrogen peroxide is genotoxic only *in vitro* systems without enzymatic activation. When enzymatic activation is incorporated in *in-vitro* systems or when tested *in vivo*, hydrogen peroxide is found non-genotoxic.[50] However, the reason why hydrogen peroxide is considered to be a risk factor to our health, is because it is a highly oxidative compound and easily decomposes into hydroxyl radicals. As a free radical with an unpaired electron, the hydroxyl radical readily attacks other molecules in its proximity and produces a new free radical and so on. The resulting damage, referred to as oxidative stress, leads to molecular and cellular dysfunction. The destruction of essential macromolecules by oxygen-based reactants is the basis of some diseases and is also believed to be involved in the processes of aging.[51] As hydrogen peroxide is capable of producing free radicals (oxygen species with an unpaired electron) which are highly reactive, it can damage proteins,

lipids, and nucleic acids. Thus, hydrogen peroxide is potentially carcinogenic and mutagenic, and can cause many degenerative diseases.

Intrestingly, an increase in the gingival health following bleaching procedures[52] reported to occur, which may be associated with toxicity of bleaching solution to the bacteria within the gingival crevice,[53] as well as due to meticulous oral hygiene maintenance to improve the results during the treatment.[15]

Further, it is difficult to predict the results of bleaching teeth for every individual, but the experience of the clinician alongwith reports may be benificial to the operators. The effect of bleaching in older patients with small pulps and dietary stains, alongwith the aging discoloration caused by secondary dentine deposition, is relatively predictable. Similarly, teenagers with yellow teeth or with basically white teeth except for the yellow canines tend to respond well to bleaching, however, browns stains are more difficult to bleach, and respond to longer bleaching regimens than stains caused by nicotine.[15,54] White fluorosis spots although tend not to bleach, but will become less obvious as a result of the lightening of the surrounding tooth area. Severe tetracycline staining may be very difficult to bleach and need to use restorations to cover the nonresponsive band, but mild-to-moderate tetracycline staining tends to respond to extended bleaching regimes of 3 to 6 months.[54]

In the end following conclusions can be drawn;

- The importance of tooth whitening for patients and consumers has seen a dramatic increase in the number of products and procedures over recent years. The key factors that affect tooth whitening efficacy of peroxide containing products are concentration and time.
- In general, higher concentrations are faster than lower concentrations. However, lower concentrations can approach the efficacy of higher concentrations with extended treatment times. Alternative bleach systems to peroxide have received only minor attention.
- The efficacy of light activated systems versus non-light activated controls in clinical studies is limited and conflicting. Bleaching techniques that have been shown to be relatively and reasonably safe and effective, both in current usage and over time should be accepted as a reasonable treatment option, knowing the risks and benefits.
- Effectiveness and safety of the bleaching technique must evaluate not only the product, but also the delivery method and treatment time.
- To conclude, the ideal stain removing agent, which can easily and quickly penetrates the tooth to selectively remove any stain without harm, awaits discovery!

REFERENCES

1. Kelleher MG, Roe FG. The safety-in-use of 10% carbamide peroxide (Opalescence) for bleaching teeth under the supervision of a dentist. Brt Dent J 1999; 187: 190-4.
2. Pretty IA, Ellwood RP, Brunton PA, Aminian A. Vital tooth bleaching in dental practice: 1. Professional bleaching. Dent Update 2006; 33: 288-304.
3. Addy A, Moran J, Newcombe R, Warren P. The comparative tea staining potential of phenolic, chlorhexidine and ant-adhesive mouthrinses. J Clin Periodontol: 1995: 22: 923-8.
4. Grossman LI, Oliet S, Del Rio CE; Endodontic Practice (1987); 11th ed, Lea and Febigee Books
5. Zaragoza VMT. Bleaching of vital teeth technique. Esto Mode O 1984; 9: 7-30.
6. Waggoner WF, Johnston WM, Schumann S, Schikowski E. Microabrasion of human enamel in vitro using hydrochloric acid and pumice. Pediatr Dent 1989; 11; 319-23.
7. Greenwall L. Bleaching Techniques In Restorative Dentistry—An Illustrated Guide. 1st ed, Martin Dunitz Ltd, 2001.
8. Pearson H. Bleaching of discolored pulpless tooth. J Am Dent Asso 1958; 56: 64-8.
9. Nutting EB, PoeGS. A new combination for bleaching teeth. Dent Clin N Am 1976; 10: 655-62.
10. Garber and Goldstein – Complete dental bleaching Quintessence Publications 1995
11. Stewart GG. Bleaching discolored pulpless teeth. J Am Dent Assoc 1965; 70: 325-8.
12. Smith HV, McInnes JW. Further studies on methods of removing brown stain from mottled teeth. J Am Dent Assoc 1942; 29: 571-6.
13. Reyto R. Laser tooth whitening. Dent Clin North Am 1998; 42: 755-62.
14. Settembrini L, Gultz J, Kaim J, Scherer W. A technique for bleaching non-vital teeth; Inside/outside bleaching. J Am Dent Assoc 1997; 128: 1283-4.
15. Sulieman MAM. An overview of tooth-bleaching techniques: chemistry, safety and efficacy. Periodontol 2000 2008; 48: 148–69.
16. Bowles WH, Ugwuneri Z: Pulp chamber penetration by H202 following vital bleaching procedures J. Endod 1987; 13: 375 – 7.
17. McCaslin J, Haywood VB, Potter BJ, Dickenson L, Russell CM. Assessing dentin colour changes from night guard vital bleaching. J Am Dent Assoc 1999; 130: 1485-90.
18. Leonard RH, Sharma A, Haywood VB. Use of different concentrations of carbamide peroxide for bleaching teeth: an in vitro study. Quint Intl 1998; 29: 501-4.
19. Frysh H, Bowles WH, Baker F, Rivera-Hidalgo F, Guillen G: Effect of pH on hydrogen peroxide bleaching agents; J Esthet Dent; 1995; 7: 130-3.
20. Brunton PA, Aminian A, Pretty IA. Vital tooth bleaching in dental practice: 2. Novel bleaching systems. Dental Update 2006; 33: 357-62.
21. Joiner A, Thakker G, Cooper Y. Evaluation of a 6% Hydrogen peroxide tooth whitening gel on enamel and dentine microhardness in vitro. J Dent 2004: 32: 27-34.
22. Luk K, Tam L, Hubert M. Effect of light energy on peroxide tooth bleaching; J Am Dent Assoc 2004; 135: 194-201.
23. Bartlett D. Bleaching in discoloured teeth: Dent Update 2001: 28: 14-18.
24. Arens D. The role of bleaching in esthetics. Dent Clin North Am 1989; 33: 319-36.

25. Gultz J, Kaim J, Scherer W, Gupta H. In office bleaching systems: A Scanning Electron Microscope Study. Compendium Oct 1999, 965-70.
26. Tam L.Vital tooth bleaching review and current status .J Can Dent Assoc 1992; 58: 654-63.
27. Barghi N. Making a clinical decision for vital tooth bleaching: At home or In- office? Compend Contin Educ Dent 1998; 19(8): 831-838
28. Tavares M, Stultz J, Newman M, Smith V, Kent R, Carpino E, *et al*. Light augments tooth whitening with peroxide. J Am Dent Assoc 2003; 134: 167-75.
29. Deliperi S, Bardwell DN, Papapthanasiou A. Clinical evaluation of a combine in-office and take-home bleaching system J Am Dent Assoc 2004; 135: 628-34.
30. Zekonis R, Matis BA, Cochran MA, Al Shetri SE, Eckert GJ, Carlson TJ. Clinical evaluation of in-office and at-home bleaching treatments. Oper Dent 2003; 28: 114-21
31. Leinbenberg WH. Intracoronal lightening of discolored pulpless teeth; a modified walking bleaching technique. Quintessence Int 1997; 28: 771-7.
32. Thickett E, Cobourne MT. New developments in tooth whitening. The current status of external bleaching in orthodontics. J Orth, 2009; 36: 194-201
33. Klutz J, Kaim J, Scherer W, Gupta H. Two in-office bleaching systems: a scanning electron microscope study. Compend Con tin Educ Dent 1999; 20: 965-9.
34. Miara P. An innovative chairside bleaching protocol for treating stained dentition: initial results ; Pract Perio Aesth Dent; 2000; 12; 669-78.
35. Goldstein CE, Goldstein RE, Feinman RA, Garber DA. Bleaching vital teeth: state of art. Quintessence Int 1997; 20: 729-37.
36. Haywood VB. Contemporary Esthetics and Restorative Practice; 1998; July: 71-81 (Available online at Assessed on 1st Oct., 2011).
37. Mastuba H, Kamjio N, Osugi NK, Toko T, Suruki T, Hisamitsu H. Self activating bleaching agent to vital teeth. J Dent Res 1997; 76: 323.
38. Nishiyama CK, Lacerda AG, Souza MH Jr, Francischone CE, Ishikiriama A, Berbert A. Bleaching of devitalized teeth with ultrasonic assistance. Rev Fr Endod. 1989; 8: 43-7.
39. Dostalova T, Jelinkova H, Housova D, Sulc J, Nemec M, Miyag M, *et al*. Diode laser-activated bleaching. Braz Dent J 2004; 15: SI3-8.
40. Zhang C, Wang X, Kinoshita J, Zhao B, Toko T, Kimura Y, *et al*. Effects of KTP laser irradiation, diode laser, and LED on tooth bleaching: a comparative study; Photomed Laser Surg;2007;25;91-5
41. Wetter NU, Walverde D, Kato IT, Eduardo CdeP. Bleaching efficacy of whitening agents activated by xenon lamp and 960-nm diode radiation; Photomed Laser Surg 2004; 22: 489-93.
42. Garber DA. Dentist-monitored bleaching: a discussion of combination and laser bleaching. J Am Dent Assoc 1997; 128: 265-30S.
43. Reyto R. Laser tooth whitening. Dent Clin North Am 1998; 42: 755-62.
44. Feinman RA, Madray G, Yarborough D. Chemical, optical and physiologic mechanisms of bleaching products: a review. Pract Periodont Aesthetic Dent 1991; 3: 32-6.
45. Pettemerides AP, Sherriff M, Ireland AJ. An in vivo study to compare a plasma arc light and a conventional quartz halogen curing light in orthodontic bonding. Eur J Orthod. 2004; 26: 573-7.
46. Lima DA, Aguiar FH, Liporoni PC, Munin E, Ambrosano GM, Lovadino JR. *In vitro* evaluation of the effectiveness of bleaching agents activated by different light sources; J Prosthodont 2009; 18: 249-54.
47. Sun G. The role of lasers in cosmetic dentistry. Dent Clin North Am 2000; 44: 831-50.
48. Howard J. Patient-applied tooth whiteners. J Am Dent Assoc 1992; 132: 57–60.
49. Ito A, Watanabe H, Naito M, Naito Y. Induction of duodenal ulcer tumors in mice by oral administration of Hydrogen peroxide. Gran 1981; 72; 174-5
50. Li Y. Tooth bleaching using peroxide-containing agents: current status of safety issues. Compend Contin Educ Dent 1998. 19: 783-96.
51. Raha S, Robinson BH. Mitochondria, oxygen free radicals, disease and aging: Trends in Biochemical Sciences 2000; 25: 502-8.
52. Reinhardt JW, Eivins SC, Swift EJ. Clinical study of nightguard vital bleaching. Quintessence Int 1993; 24: 379-84.
53. Bentley CD, Leonard RH, Crawford JJ. Effect of whitening agents containing carbamide peroxide on carcinogenic bacteria. J Esthet Dent 2000; 12: 33–37.
54. Haywood VB. A comparison of at-home and in-officen bleaching. Dent Today 2000; 19: 44–53.