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Oral Presentations

ABSTRACT 1

Photobiomodulation and Photobioinhibition of Cancer Stem Cells

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ABSTRACT

Background: Cancer stem cells (CSCs) have been implicated as an important contributory factor in the development of metastasis. CSCs have the same characteristics as normal stem cells; they can proliferate indefinitely and are capable of both self-renewal and differentiating into specialized cells. The molecular and cellular characteristics of stem cells and CSCs are coded for by cell-specific genes, which can be analysed using molecular assays. Low-intensity laser irradiation (LILI) has been applied in the treatment of numerous diseases and pathological conditions. Photobiomodulation has been shown to stimulate proliferation of cells, capillary growth, and cellular metabolism as observed by ATP activation. It has been shown, by using different fluences and wavelengths, LILI, can either stimulate or inhibit cellular functions. Cancer research is highly focused on improving current cancer treatments. One of the methods of targeted cancer therapy is photodynamic therapy (PDT), where LILI, along with a photochemical compound, is used. When implementing a mechanism by which CSCs are targeted, LILI might be a viable treatment option. Studies have shown that using high fluences of LILI (HF-LILI) cell death may be induced in normal and neoplastic cells.

Methods: In our work, lung and breast CSCs were isolated using stem cell markers and irradiated at wavelengths of 636, 825 and 1060 nm, with fluences ranging from 5 J/cm^2 to 40 J/cm^2. Post-irradiation biochemical assays were conducted after 24 hours to monitor cellular responses including proliferation and cytotoxicity3.

Results: Lung, cervical and breast CSCs were successfully isolated from cancer cells using stem cell markers and fluorescent imaging to confirm characteristics.

Conclusion: Results indicate that LILI, when treating CSCs, can induce either a bio-stimulatory or bio-inhibitory effect depending on the wavelength and fluence used. This study indicated successful cell damage in CSCs when using HF-LILI, as well as, stimulation of ATP production when using lower fluences of LILI.

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ABSTRACT 2

Lasers in Implantology

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ABSTRACT

Nowadays the use of implants as an increasing therapy in dentistry and it has become a usual treatment in dental offices. More and more dentists have dental implants included in treatment plans for patients with missing teeth. Therefore is necessary that all dentists know all the possibilities of these treatments. Together with the emergence of dental implants, it is also beginning to see an increase in the onset of lasers in dentistry.

These two new techniques in dentistry can be supplemented because as we will see the use of lasers in different cases can improve implant treatment

The laser implantology applications can be classified by the time that we are going to use it. We can use it in the first surgical phase, during the second surgical phase or on posterior phases that present some soft tissues or perimplantitis alterations.

First surgical stage: In this phase we can use surgical lasers as Er:YAG and Er,Cr:YSGG to prepare the bone so the implant can be placed. Different studies have demonstrated that it can improve and accelerate the osseointegration, when they are compared with other conventional methods. Lee & cols compared the values of stability implants (ISQ) between the samples one made with laser and the other one with conventional bur technique. They observe that there are no differences.

To sum up we can say that on one side we have that the sample of the bone made with Er:YAG or Er,CR:YSGG laser is a reliable one, and does not influence negatively in contact with the bone implant, but there is an increase of the needed time and a risk of nobles injuries (vessels and nerves).

On the other side during the first surgical phase it also can be use the low level laser. In different experimental in vitro studies it has been compared how the irradiation with low level laser LLLT during the first surgical implant phase can speed up the wound process producing a biostimulation effect on the osteoblasts.

Second surgical stage: Before this treatment can be enforce, the possible effects of the laser on the implant surface have to be established. That is why there is a need to know what are the laser effect on the surface of the implant and also if the temperature of tissues surrounding the implant is increased by the laser irradiation.

In reference to the increment of the temperature in numerous studies, there evaluated this increment in function of the used wavelength.

Lasers such as Nd:YAG have shown they can produce a thermic damage in the adjacent bone to implants due to a temperature increment, so its use is discouraged in implantology. However Er,Cr:YSGG and Er:YAG laser on the implant surface do not generate a thermic increase as long as is used with refrigeration. Diode laser can increase the temperature above 10ºC when is irradiated for more than 10 seconds.

In the second-stage surgery of submerged healed implants Er:YAG or Er,Cr:YSGG laser has a successful result, but implants located in aesthetic zone or in areas with insufficient surrounded by keratinized mucosa it will be a problem. In order to improve these results, we purpose a new technic to improve this procedure so instead to eliminate all the keratinized mucosa, we recommend a rolling-flap, so that the keratinized mucosa in palatine zone can be move to the buccal zone so the keratinized mucosa is preserved to the maximum.

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ABSTRACT 3

The Evidence of LLLT in Oncology Patients, and its Safety

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ABSTRACT

There is a large body of evidence supporting the efficacy of low-level laser therapy (LLLT) studies, more recently termed photobiomodulation (PBM), for the management of oral mucositis (OM) in patients undergoing radiotherapy for head and neck cancer (HNC).

Recent advances in PBM technology, together with a better understanding of mechanisms involved, may expand the applications for PBM in the management of other complications associated with cancer treatment.

We review PBM mechanisms of action and dosimetric considerations. Virtually all conditions modulated by PBM (e.g., ulceration, inflammation, lymphedema, pain, fibrosis, neurological and muscular injury) are thought to be involved in the pathogenesis of (chemo) radiation therapy-induced complications in patients treated for cancer. The impact of PBM on tumor behavior and tumor response to treatment have been insufficiently studied. In vitro studies assessing the effect of PBM on tumor cells report conflicting results perhaps attributable to inconsistencies of PBM power and dose. Nonetheless, the biological bases for the broad clinical activities ascribed to PBM have also been noted to be similar to those activities and pathways associated with negative tumor behaviors and impeded response to treatment. While there are no anecdotal descriptions of poor tumor outcomes in patients treated with PBM, confirming its neutrality with respect to cancer responsiveness is a critical priority.

Based on its therapeutic effects, PBM may have utility in a broad range of oral, oropharyngeal, facial, and neck complications of cancer treatment. Although evidence suggests that PBM using LLLT is safe in cancer patients, more research is imperative and vigilance remains warranted to detect any potential adverse effects of PBM on cancer treatment outcomes and survival.

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ABSTRACT 4

Low Level Laser Therapy/Photobiomodulation Therapy Mechanisms of Action, Clinical Evidence and Dose Rate Effects

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ABSTRACT

There are ~500 randomized clinical trials evaluating low level laser therapy (LLLT) / photobiomodulation therapy (PBMT) and ~4000 in vivo or in vitro laboratory studies exploring the mechanisms of action and dose response. Applications include wound healing, chronic degenerative joint conditions, neuropathic pain, myogenic pain, and even disorders of the heart, brain, and spinal cord. For oral cavity and maxillofacial applications, there are ~1000 published papers including temporomandibular joint dysfunction, post-surgical pain, orthodontic pain, HSV, oral lichen planus, oral mucositis, burning mouth syndrome, iatrogenic inferior alveolar nerve injury to name just a few.

Systematic reviews published by the World Health Organization, the Lancet, and British Medical Journal support the use of this therapy, the UK NHS is funding efficacy and cost-benefit trials on oral mucositis, and now American insurance companies are declaring the treatment as “medically necessary” for oral mucositis. One of the best-understood mechanisms for these effects starts with the absorption of light by cytochrome c oxidase (the terminal enzyme in the electron transport chain in mitochondria).

Absorption of this light triggers a cascade of effects that lead to a decrease in inflammation and faster tissue repair. These events are subject to a dose-response; not enough light and nothing happens, too much light and the benefits are lost. The thresholds and limits for these effects will be presented along with evidence of clinical outcomes from randomized controlled clinical trials.

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ABSTRACT 5

Resolution of Blue Light-Bacterial Interaction Through Spectrally Resolved Fourier Transform Infrared and Chemometric Tools

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ABSTRACT

Multidrug-resistant microorganisms in hospital and community environments have been on the rise and of great concern to clinicians, patients, and the pharmaceutical industry. As a part of the ongoing effort to find a lasting solution to the menace of bacterial resistance to antibiotics, our team proposed a paradigm shift from antibiotic therapy to using certain wavelengths of light to eradicate infection, including those occasioned by deadly drug-resistant bacteria. Since then, our work and those of others continue to show that this promising technology clearly inactivates a host of Gram-positive, Gram-negative, aerobic and anaerobic-antibiotic resistant microorganisms including methicillin-resistant *Staphylococcus aureus* (MRSA), *Propionibacterium acnes, Pseudomonas aeruginosa, Salmonella enterica* serovars Typhimurium and Heidelberg and others. The versatility of blue light in inactivating microbes is documented, however, the mechanism of bacterial death remains unclear.

Fourier transform infrared (FTIR) spectroscopy and chemometric tools were used to uncover a possible mechanism implicated in the inactivation as the bacteria progressed toward apoptosis. Principal component analysis followed by linear discriminant analysis (PCA-LDA) were employed to reveal clustering of 5 groups of samples, namely untreated MRSA (control I), untreated MRSA incubated at ambient air (control II), irradiated MRSA with 470 nm light, irradiated MRSA with 253.5 UV light, and vancomycin-treated MRSA. Important functional groups in proteins, lipids, and nucleic acids region, that were responsible for the classification of various spectra, were depicted.

Cluster vector plots and scores plot revealed that UV light-irradiated spectra were the most biochemically similar to blue light irradiated spectra; however, some wavenumbers experienced a shift.

These findings indicate that irradiation of MRSA with 470 nm light induced A-DNA/RNA cleavage and that B-DNA was more resistant to damage by blue light. Blue light and UV light treatment of MRSA were complementary and distinct from the known antimicrobial effect of vancomycin. Moreover, our FTIR findings confirmed the well-known UV-induced cleavage of DNA which predominantly targets B-DNA. Overall the results suggest that the combination of light and vancomycin could be a more robust approach in treating MRSA—and perhaps other bacterial infections—since they target A and B-DNA respectively.

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ABSTRACT 6

Value Added Cleaning and Disinfection of the Root Canal: Ultrasound Versus Laser-Activated Irrigation and PIPS (Photon-Induced Photoacoustic Streaming)

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ABSTRACT

Background: Among present-day marketed systems ultrasonic activation appears to be the best way to activate and potentiate endodontic irrigants. An alternative for ultrasonic activation of irrigants is laser activated irrigation (LAI) or photon-initiated acoustic streaming (PIPS). The aim of this presentation is to demonstrate how the interaction with endodontic biofilms, smear layer and debris accumulated during root canal preparation differs between ultrasonically activated irrigation (UAI) (previously referred to as PUI – passive ultrasonic irrigation) and LAI. As LAI is associated with vigorous irrigant dynamics, questions have been raised about its safety. Therefore, the topic of evaluation of eventual extrusion during both LAI and PUI/UAI is also addressed.

Methods: The information presented is supported by present-day research and up-to-date scientific data i.e. findings in the peer-reviewed literature with impact factor, and data coming from investigations conducted at the Ghent Dental Laser Centre (debris removal, interaction with endodontic biofilm, registration, and visualization with a high speed camera, extrusion studies)

Results: It appears that activation of endodontic irrigants with Erbium lasers can be more efficient as well as more effective than with ultrasound, and this on both level of interaction with debris and smear layer. Mechanical removal of the biofilm is also more pronounced with Erbium LAI. While the agitation of irrigants during ultrasonic activation is the result of a sinusoidal movement of files or wires and acoustic streaming around the instrument, fluid motion during LAI is induced by specific cavitation phenomena thanks to the absorption of the Erbium laser light in the aqueous endodontic irrigation solutions. LAI has evolved over the last 10 years. Originally the fiber was positioned in the apical third of the prepared root canal. Long pulses up to 200 µs and energy up to 250 mJ were used. Later on, the fiber was positioned in the coronal third or in the orifice, which was possible due to a better understanding of the cavitation phenomenon and changes in applied power density. Today LAI is performed with the fiber in the pulp chamber according to the PIPS approach: short pulses of 50 µs and low energy i.e. 20 to 40 mJ are used.

Conclusion: PIPS activation results in more negative bacterial samples and less apical biofilm left when compared to UAI, more debris is removed and a more profound cleaning and disinfection of the isthmus is obtained.

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ABSTRACT 7

Making a Difference: Laser Assisted Diagnosis of Caries, Scoring Caries Activity, and Assessment of Pulp Vitality

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ABSTRACT

Background: Timely diagnosis of disease is the mainstay of comprehensive diagnosis. Early detection of caries, the assessment and the judgment of the activity of the lesions are important parameters during decision making as the start of minimal intervention procedures. This also accounts for the timely diagnosis of pulpal disease and the determination and correct evaluation of pulp vitality in its different stages in trauma cases. The question does laser light will provide us with value-added technology to make the difference with conventional diagnostic means and devices. The aim of this presentation is to demonstrate how the use of lasers can make a difference with conventional diagnostic means in the field of caries diagnosis and determination of caries activity in order to install minimal invasive treatment and to avoid pulpal exposure during excavation in deep caries lesions.

Methods: The information presented is supported by present-day research and up-to-date scientific data i.e. findings in the peer-reviewed literature with impact factor and data coming from investigations conducted at the Ghent Dental Laser Centre.

Results: When enamel, dentine and substances in caries lesions are exposed, to laser light of a specific wavelength, fluorescence may be induced. This principle is at the basis of e.g. caries diagnostic methods such as DIAGNOdent and Quantitative Laser (Light-induced) Fluorescence (QLF). Bacterial porphyrins evoke fluorescence when illuminated with red light and the intensity of the emitted light is related to the size of the caries lesion. QLF is based on the fluorescence decrease in demineralized enamel upon exposure to blue-violet laser light. The intensity of the emitted light is related to the amount of mineral loss in the caries lesion. Like the DIAGNOdent, QLF is particularly suitable to monitor caries lesions. DIAGNOdent is also shown to be applicable for caries diagnosis during extensive caries removal. In deep caries lesions in unfilled teeth, laser fluorescence is of help to make a distinction between the affected and infected layer and hence, the application of the stepwise excavation technique with a far lower risk of pulp exposure than with complete caries removal. An early determination of pulpal vitality is crucial with respect to a correct differential diagnosis of revascularisation or necrosis and its treatment. The use of sensibility tests in combination with X-ray is commonly promoted. However, these tests are arbitrary, based on sensations, and therefore not always reliable. In such situation, registration of pulpal blood flow will be more than an added value. Recent investigations at GDLC have also demonstrated that it was possible to register the diurnal variations in the pulpal blood flow. The latter appears to be an important parameter during the follow-up of trauma cases.

Conclusion: It has been demonstrated that laser fluorescence devices have better accuracy in detecting more advanced caries lesions and that the methods are efficacious individually. The use of laser fluorescence during stepwise excavation appeared to be very helpful in avoiding pulp exposure during caries removal in deep caries lesions extending close to the pulp. Laser Doppler Flowmetry (LDF) is a non-invasive technique with direct and objective registrations. Despite a low implementation of LDF in dentistry, this technique has proven to be an indisputable basic asset of a dental (trauma) clinic.

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ABSTRACT 8

Evidence-Based Laser Assisted Periodontics

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ABSTRACT

Removal and elimination of bacterial biofilm from the root surface is an essential part of periodontal treatment. Nd:YAG lasers, diode-lasers, and Erbium-lasers show a high antibacterial effect in the periodontal pocket. Additionally, these lasers can be used as minimally invasive surgical tools to remove the pocket epithelium. Debridement of the root surface from hard calculus deposits is only possible with the Er:YAG and the Er,Cr:YSGG lasers.

In periodontal regenerative procedures, the laser light of the Erbium-lasers might be used for root surface conditioning. Recent reviews concluded that the diode lasers and Nd:YAG lasers provide a benefit as an adjunct to conventional periodontal treatment. The presentation gives an overview of the literature, the techniques and how lasers could be a part of modern periodontal treatment.

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ABSTRACT 9

Er:YAG in Conservative Dentistry

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ABSTRACT

Background: The use of laser technology in conservative dentistry was proposed in 1990 by Hibst and Keller who described the possibility to employ Er:YAG laser as an alternative to conventional rotating instruments. In facts, thanks to the affinity of this wavelength (2940 nm) to water (absorption peak = 3000 nm) and hydroxyapatite (absorption peak = 2800 nm), Er:YAG laser allows an efficient ablation of hard dental tissues without the risk of micro- and macro-fractures, often observed with the use of conventional rotating instruments. The dentin surface treated by laser appears clean, without smear-layer and with the tubules open and clear. The aim of this clinical study was to demonstrate, by the description of different clinical cases, the possibilities and the advantages of the use of Er:YAG lasers in conservative dentistry and also to show that better results may be achieved in terms of stronger adhesion, less invasiveness, reduced pain as well as greater comfort and satisfaction of patients.

Methods: The advantages of the use of Er:YAG laser in adhesive dentistry is demonstrated by the description of a great number of cases in different clinical situations, with different parameters and techniques, and with follow-up observations.

Results: All the cases reported showed good functional and aesthetic results with great satisfaction from the patients. In most cases, anaesthetic injection was avoided without pain and discomfort. Thermal elevation in the pulp, recorded during Er:YAG laser irradiation, was lower than that recorded by using a turbine and micro-motor with the same conditions of air/water spray. This wavelength also produces an antimicrobial decontamination effect on the treated tissue, which destroys both aerobic and anaerobic bacteria. The most interesting aspects of this new technology may be related to the goals of modern conservative dentistry: i.e. minimally invasive treatments and adhesive dentistry. In fact, Er:YAG lasers can reach spot dimensions smaller than 1 mm, thus enabling a selective ablation of the affected dentin with preservation of the surrounding sound tissues. Moreover, several in vitro studies have demonstrated that the preparation of enamel and dentine by Er:YAG laser, followed by orthophosphoric acid-etching, enhance the effectiveness in terms of reduced micro-leakage and increased bond strength. For this reason the role of the Er:YAG laser in modern conservative dentistry is of greater and greater importance: it is able to make a very small cavity and, by realizing a rough surface, to increase the adhesion of the composite resin. If this is desirable in the whole of conservative dentistry, it becomes strictly necessary in particular clinical situations where a minimal volume of ablation and/or greater adhesion are required, i.e. pits and fissures sealing, fluorosis or enamel defects, spots and crown fractures of frontal teeth. The follow-up observation of the described cases confirmed the long-term stability of the results, both in term of functionality and aesthetics.

Conclusion: Er:YAG laser was demonstrated to be a good device in conservative dentistry; it may replace the conventional rotating instruments with several advantages in terms of patient comfort, results, and longevity.

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ABSTRACT 10

Photodynamic Therapy in Oral & Maxillofacial Lesions

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ABSTRACT

Oral cavity cancer is a major global problem exacerbated by the use of tobacco, habits such as Paan chewing, and alcohol consumption. There is clearly a need for a preventative program, however, most cases present with advanced disease and in this scenario, despite advances in reconstruction and radiotherapy delivery, little impact has been made on survival.

Photodynamic therapy (PDT) is a treatment that involves an oxygen-dependent photochemical reaction that produces cell death by a combination of apoptosis and vascular damage. A series of studies demonstrated treatment safety with good healing, no nerve damage, safety in close proximity to major blood vessels in the head and neck and subsequent clinical trials have duplicated these effects in humans.

There have been many studies on all aspects of head and neck cancer from dysplasia through to palliative treatment of advanced disease and these will be presented.

The exact future of PDT is a little unclear. It has been widely used in China, Russia Indonesia, and South America but has faced opposition in Europe from pharmaceutical companies, conservative surgeons and, radiation oncologists. However, it should not be seen as a competitor to established therapies but rather as an adjunct.

Finally, there are many applications of PDT in benign disease and probably most importantly in antimicrobial action.

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ABSTRACT 11

Dentinal Hypersensitivity and Lasers

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ABSTRACT

Cervical dentinal hypersensitivity is a widespread disease with tremendous adverse effects on the patients' comfort.

Between 8%-57% of the total population is affected by this disease. Literature even states a prevalence of over 90% in patients with periodontal disease.

Conservative treatment techniques provide, in most cases, no satisfying results because the seal of dentinal tubules and surface coatings are ephemeral due to tooth brushing and abrasive and erosive food particles. General practitioners have to face this problem in their daily business.

To increase our patients' comfort, innovative and new treatment strategies are needed.

This presentation shows a new approach for the reduction of cervical dentinal hypersensitivity with lasers, it deals with different wavelengths and possible materials that help to seal the cervical regions. It summarizes the effects of lasers and shows the advantages as well as the limitations of different wavelengths.

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ABSTRACT 12

Evidence-Based Laser Assisted Periodontics

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ABSTRACT

Removal and elimination of the bacterial biofilm from the root surface is an essential part of periodontal treatment. Nd:YAG-lasers, diode-lasers, and Erbium-lasers show a high antibacterial effect in the periodontal pocket. Additionally the Er:YAG and the Er,Cr:YSGG lasers can be used for the debridement of the root surface. The presentation gives an overview of the recent literature and how lasers could be a part of modern periodontal treatment.

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ABSTRACT 13

Latest Scientific Results in Dental Hard Tissue Preparation

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ABSTRACT

Among many other indications for the use of lasers in dentistry, there is a field of application, where the laser has brought major proceedings and specific advantages: The dental hard tissue preparation. Using the Erbium - laser, enamel and dentin can be ablated without thermal side effects due to the photo ablative impact of this wavelength.

The laser light is absorbed by water within the hydroxyapatite; the water is heated and evaporates instantly. Due to the volume change, particles of the dental hard substance are blown out of the tissue and a cavity is created. The whole procedure is almost painless and therefore well accepted by the patients. Composite restorations can be placed without acid etching because of the retentive surface delivered by the laser. To find the right power settings and the optimal handling of the laser fiber, a comprehensive SEM study has been performed. In addition, different bonding systems have been compared and an optimal quality of bonding has been evaluated.

The investigations showed that through the optimization of different influence factors results can be achieved which are far superior to those achieved by the use of traditional preparation techniques. Get to know the latest results of the influence of lasers on the collagen fibrils.

CO2, Diode, and Erbium lasers are widely used in dentistry, producing very satisfying results. Another application for these wavelengths in conservative dentistry is the treatment of hypersensitive dental necks. The laser is applied at rather low energy settings in conjunction with fluoride gel. In most cases, one appointment is sufficient to achieve permanent freedom from pain even in patients who suffer from severe symptoms.

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ABSTRACT 14

Laser Phototherapy on Bone Repair: From the Bench to the Dental Chair

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ABSTRACT

Bone losses are major problems in many medical and dental specialties and occur due to several physiologic and pathologic conditions. Several therapeutic techniques are clinically used attempting to promote acceleration and /or improvement of bone repair, including the use of coherent or non-coherent light. We highlight the laser light used for laser phototherapy (LPT).

Over the past 20 years, experimental protocols have been proposed for a considerable number of procedures involving the repair of bone in both animals and humans. These protocols are now used also as aids for an efficient repair of mineralized tissues as LPT accelerates the bone repair by directly affecting, in many ways, new bone formation. It is known that the stimulant effect of the IR laser light on bone occurs during the initial phase of proliferation of both fibroblasts and osteoblasts as well as on initial differentiation of mesenchymal cells. Fibroblastic proliferation and its increased activity have been detected previously on irradiated subjects and cells cultures and these are responsible for great concentration of collagen fibers seen within irradiate bone.

Our previous studies indicate that the effective outcome of LPT is observed when the treatment is carried out at early stages when high cellular proliferation occurs. The Vascular responses to LPT were also suggested as one of the possible mechanism responsible for the positive clinical results observed. The possibility of influencing selectively bone formation by controlling both the quality and quantity of bone has become a reality due to the technological development of biomaterials and on the important evolution in the methods and knowledge of cellular and molecular biology that occurs on these events. LPT is a modern tool that we use in our daily clinical practice.

Laser is a new instrument that few dentists use, but in the future, it will be a natural part of our equipment. However, the mechanism of effect of LPT is complex, making its understanding difficult. LPT is another treatment option that may be offered to our patients in daily clinical practice.

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ABSTRACT 15

Photobiomodulation Therapy – An Innovative Approach to Precision Photomedicine for Regenerative Therapies With Endogenous Stem Cells

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ABSTRACT

The use of biophotonics devices has pervaded many aspects of clinical medicine from simple fiberoptics for lighting to high power lasers for precision surgery. Advances in our understanding of light-biological tissue interactions are leading innovative new applications. These include low dose biophotonics for various forms of therapy such as antimicrobial photodynamic therapy (PDT) and photobiomodulation (PBM) therapy. This latter modality has significant implications for future clinical dentistry given its broad impact on immunomodulation, analgesia, wound healing and tissue regeneration. This presentation will present our salient research findings over the past 2 decades that has focused on molecular mechanisms of PBM therapy.

Our prior work observed a key role for the mediating of these biological responses and has uncovered a novel role of a latent growth factor, TGF-beta1, activation as one of the major extracellular mediators. We have noted a key role of an amino acid on the growth factor complex, a methionine at position 253 that acts as a redox sensor for the laser-generated ROS. Activation of this multi-faceted growth factor has potent biological implications for wound healing, immunomodulation and stem cell differentiation. This presentation will provide a brief overview of our work investigating these applications, specifically emphasizing the ability of PBM therapy to promote tissue regeneration by expansion and directed differentiation of stem cells from a wide range of anatomical niches such as bone marrow, skin and mucosa, and dental pulp.

A major goal of our research group is to promote human clinical translation of PBM therapy. We have been examining the key physical (device) and biological (mechanisms) factors to promote the development of safe and effective clinical PBM protocols. While it is well established that phototoxicity at high doses results from thermal and excessive ROS, the precise molecular pathway had not been described.

Our recent efforts have observed a key role of cell stress in the endoplasmic reticulum induced by PBM laser doses are mediated by a central photoreceptive factor, ATF-4 that makes critical cell survival versus cell death decisions.

The practical implication of these studies is that ATF-4 can be used as a precise molecular biomarker to determine maximal PBM therapeutic dosing within the non-thermal regimen. This presentation will highlight these studies and our ongoing efforts to enable wider realization and acceptance of the tremendous potential of PBM therapy to revolutionize healthcare.

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ABSTRACT 16

The Er:YAG Wavelength for an Extended Management of Oral Soft and Hard Tissues: From Ablative Oral Surgery to Non-ablative Anti-snoring Therapy, Both as Reflections of 2 Different but Complementary Concepts of Er:YAG Laser Therapy

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ABSTRACT

An innovative high-level generation of pulses allows us to perform, with the Er:YAG laser, a very selective hard and soft tissue removal. Oral surgery is one of the very popular domains, where we can choose Er:YAG as a team leader for almost any indication, due to the right selection of pulse quality, pulse duration and corresponding settings of energy and pulse rate.

From ablative to non-ablative: a fully controlled energy transfer to soft tissue permits a new non-invasive anti snoring therapy, completed by a specific patient interview and checkup procedure, lifestyle support, and a complete clinical protocol.

Laser-activated irrigation with the fiber in the root canal is more efficient than passive ultrasonic irrigation ultrasonically activated irrigation (PUI/UAI). The photon induced photoacoustic streaming (PIPS™) approach is also more efficient than PUI/UAI on the condition that there is intense fluid streaming i.e. used in combination with simultaneous irrigation. Both techniques can also be considered safe when the correct protocol is followed.

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ABSTRACT 17

New Findings of Photobiomodulation in Dentistry

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ABSTRACT

Dentists were among the first academic adopters of PBM in spite of a rather meager scientific documentation. The observed effects were sufficient for many dentists, but those more scientifically inclined remained skeptic. As with all new therapies, the documentation has grown over the years and we have arrived at a situation where we can safely say that this is a method based on science. Still, we need to learn more about the intricate biological effects and about the best irradiation parameters, but that is not a unique situation for PBM. Our knowledge has gone from early anecdotal reports, to in vitro reports, animal studies and to RCTs.

Two aspects of PBM have been attractive. One is the ability to substitute pharmaceuticals like opioids and NSAIDs with PBM, avoiding the many side effects of these pharmaceuticals. Yet another is the possibility to expand the scope of dentistry into new areas. The use of PBM to prevent or treat radiation-induced mucositis has been well documented during the years, and not least important, it has been proven to be highly cost-effective. Paraesthesia is a feared consequence of surgical interventions where treatment options are lacking. The use of PBM can not only reduce the risk for permanent or long-time paraesthesia but also treat them once it occurred. A particular area for PBM is non-responders. Dentistry offers a wide array of highly effective therapies but subgroups will not respond well. Using PBM in combination with traditional methods will be more effective, for instance for diabetics and for immunosuppressed patients. Overall, pain, edema, and inflammation are linked to dentistry.

We treat these conditions but also have to cause them temporarily. PBM works well in all these three areas. Understanding this fact makes it easier to understand why PBM can work in so many different conditions. For instance, PBM has been documented as more effective than Botox for TMD. It has also been documented as useful in the treatment of somatosensory tinnitus, another area of TMD. Other documented areas are neck pain, pemphigus vulgaris, sinuitis, hypo-salivation, oral lichen planus and burning mouth syndrome.

The biological effects of the blue curing LED have been underestimated and need more research. Certainly, more documentation is required, but again, considering the lack of side effects, PBM offers quite attractive options. Last but not least, PBM offers an in-clinic possibility of treating staff related problems such as shoulder and neck pain, carpal tunnel, burns, arthritis etc.

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ABSTRACT 18

Insight in the Photochemistry of Laser and Light Activated Dental Systems

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ABSTRACT

In 1917, Albert Einstein published a paper “On the Quantum Theory of Radiation”, which resulted many years later in the first laser devices. The very same year, he published also his famous “General Theory of Relativity”. But already in 1905, he described “The Photoelectric Effect” for which he received in 1921 the Nobel Prize. In this article, Einstein explained how photon energy can interact with matter. This formed the basis for the study of photochemistry where photon energy induces chemical reactions. The most commonly known is the photochemistry in the chlorophyll of plant cells, which creates life on earth. But also in our daily work in dentistry, we use photochemistry all the time.

It is the intention of this lecture to summarize our actual insights on how laser and light interactions with matter and tissues induce the effects we experience and use in our patient treatments. And, as an example of this, how photochemistry may form the basis of how dental bleaching without the use of hydrogen peroxide may be possible.

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ABSTRACT 19

Evaluation (Benefits) of Photodynamic Therapy and Laser Application in Periodontal Therapy

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ABSTRACT

Up to today the efficiency of photodynamic therapy and laser application for the treatment of periodontitis is still a controversially discussed issue. However antibacterial effects have been demonstrated by experimental studies and clinical trials.

The optimal calculus removal and minimal damage to the root surface, as well as bio-modification of root surface topography, appear attractive for using lasers in comparison with conventional instruments. The objective of this lecture is to give an overview of the clinical evidence of photodynamic and laser therapies in the treatment of periodontitis. In particular, results will be presented from a recent case-controlled study for the evaluation of photodynamic application as an adjuvant therapy in the treatment of periodontal patients.

The demonstration of its bactericidal effects against periodontal pathogens will be discussed. In comparison to antibacterial photodynamic therapy (aPDT) various lasers do not only provide antibacterial effect but also modify the topography of dental root surface that favors cell attachment of periodontal tissues. The lecture will also present another in vitro study to compare dentin surface ablated with an ultra-short pulsed laser (USPL), Er:YAG laser or grounded with a carbide bur.

The results showed micro-structural changes of dentin surfaces ablated with USPL and Er:YAG laser. Consequently, attachment and differentiation of periodontal ligament cells were improved. In conclusion, periodontal tissue regeneration appears to be promoted with laser therapy provided adequate parameter setting and its correct clinical application.

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ABSTRACT 20

Clinical Investigation of Microbial Count in Laser-Assisted Endodontics by 810 nm Diode Laser: An In Vivo Research

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ABSTRACT

Background: Clinical evaluation of microbial reduction in laser-assisted endodontic treatment by diode laser 810 nm, an in vivo study.

Methods: Forty teeth of single canals were treated in 40 patients in 2 groups. The laser group with 20 patients, control group with 20 patients. After access to the pulp chamber a kfile 10 was inserted into the canal to move in the pulp then canal was irrigated with 0.2 mL sterile saline solution. The canal was dried with 3 sterile paper points Iso 20. Each paper cone was left inside the canal after 30 seconds. These paper cones as first microbial samples were added to 200 BHI broth and sent to the microbiology laboratory. In the laser group, the canals were sterilized with 810 nm, 2W power, 200 µm fiber in continuous mode (CW), 2 mm/s radiation time, after 5 seconds of irradiation a 5 seconds rest, 4 times for each canal from apical to coronal with a circular movement. The second microbial samples were taken in both groups before obturation and sent to the microbiology laboratory.

Results: The results show a reduction of 100% bacterial colonies by 810 nm diode laser with this new protocol.

Conclusion: Diode laser, 810 nm, with this new protocol, 2 W, CW can kill all of the microbial colonies in laser-assisted endodontic.

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ABSTRACT 21

Evaluation of Different Lasers Combination Effect on Osseous or Cartilaginous Differentiation of Bone Marrow Mesenchymal Stem Cells

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ABSTRACT

Background: Tissue engineering is one of the scientific branches for regenerating impaired tissues by differentiating undifferentiated stem cells to proper target ones. Lasers are well-recognized energy sources to promote cell proliferation and differentiation. Although several studies showed the effects of lasers alone, there is no significant information on lasers combination and their effect on the cell.

Methods: Mesenchymal stem cells were derived from rabbit iliac bone marrow. One control and 8 laser irradiated groups were designed as Red (R), Infra-red (IR), Blue (B), Green (G), IR-R, IR-B, R-G, B-G. Lasers were irradiated for 21 days and cell proliferation, osseous or cartilaginous differentiation were assessed during this period. SOX9, Aggrecan, COL II, and COL X expression were evaluated for cartilaginous differentiation and ALP, COL I and Osteocalcin expression were evaluated for osseous differentiation by real-time PCR.

Results: Cellular proliferation was increased in all irradiated groups except G. All cartilaginous markers were significantly increased by IR and IR-B laser irradiation except COL X which was suppressed by IR-B combination therapy. ALP expression was highest in R and IR laser groups during osseous differentiation. This measure was decreased by a combination of IR laser with B and R lasers and also by G laser irradiation solely. R and B-G groups stimulated COL I expression, however, IR-B, IR-R, and G groups suppressed this factor. IR laser significantly increased osteocalcin expression, however, B, B-G and G groups had an adverse effect in this regard.

Conclusion: Cartilage differentiation was stimulated by IR and IR-B lasers irradiation. The effect of single or combined lasers irradiations were not definite on osseous differentiation. It may be considered to expect stimulatory effect for red and infer-red lasers, while green laser has had an inhibitory effect on osteodifferentiation.

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ABSTRACT 22

CO2 Laser and Fluoride; Effect on Enamel Remineralization

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ABSTRACT

Background: Incipient enamel lesions are potentially able to remineralize. So, preventive modalities that rely on tooth remineralization are helpful in the conservation of the tooth structure. Fluoride, as a routine caries preventing agent, can only partially impart cariostatic properties. In the present study, the effect of CO2 laser alone or in combination with titanium tetrafluoride on enamel remineralization was investigated.

Methods: The study was performed on human enamel specimens. After measuring the hardness of artificially demineralized samples with Vicker's hardness tester, they were randomly divided into 5 study groups (n=15): G1: control; G2: APF 1.23% (positive control); G3: TiF_4 4%; G4: TiF_4 4% followed by CO_2 laser; G5: CO_2 laser followed by TiF_4 4%. Laser parameters were as follows: 10.6 µm wavelength, 1 W peak power, 10 ms pulse duration, 500 ms repeat time, 0.2 mm beam spot size, 2 cm distance. After finishing the treatments, surface hardness was measured again. 3 samples in each study group were observed under scanning electron microscope ×1000. Data were analyzed by repeated measure ANOVA and Bonferroni tests. Level of significance was set at 0.05.

Results: The control and Laser- TiF_4 groups indicated significant differences with the other groups ($P<0.05$). The difference between control and Laser- TiF_4 group was not significant ($P=0.7$). There was not a significant difference between APF and TiF_4, APF and TiF_4-Laser, and also between TiF_4 and TiF_4-Laser ($P=1$). According to the results, the effectiveness of TiF_4 and TiF_4-laser was similar to the positive control group (APF). TiF_4 protects the tooth by forming a protective barrier of TiO_2 against noxious agents (mechanical protection) and increasing the fluoride uptake into the enamel surface (chemical protection) by the high acidity of HF formed in the aqueous environment of the oral cavity.

The results of the present study regarding the laser-TiF_4 group were different from the results obtained by Poosti et al. The reason may be related to the shorter distance and smaller spot size of the laser in the present study, which have caused unfavorable mechanical alterations which could prevent caries remineralization. Some changes might have also occurred in the organic volume of enamel, which have changed the proper substrate for TiF functioning.

Conclusion: APF, TiF_4, and TiF_4-Laser significantly increased the surface hardness of artificially demineralized enamel samples. Laser-TiF_4 treatment could not increase the hardness of white-spot lesions.

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ABSTRACT 23

Effects of CO2 Laser Therapy on Resistant Oral Lichen Planus

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ABSTRACT

Background: Oral lichen planus (OLP) is a chronic mucocutaneous disease with no specifically identified etiology and pathogenesis. Different causes are proposed to be related to OLP, including stress, genetics, systemic diseases, medicines, dental restorative materials, and viruses. Some of these lesions are resistant to the typical corticosteroid therapy. This study was aimed at evaluating the therapeutic effects of CO2 laser therapy on OLP.

Methods: In the present clinical experiment, 50 patients with a histopathologic diagnosis of OLP and resistance to local corticosteroids were studied. The patients were divided into 2 groups: control group (treated with local corticosteroids) and experimental group (treated with CO2 laser). Before the study, 15 days, 1, 3, and 6 months after treatment, the pain level was measured with visual analogous scale (VAS) and the size of the lesion was determined. Efficiency index (EI) was utilized to evaluate the changes in lesion size. The collected data were analyzed using Freedman and Mann-Whitney tests through SPSS 18.0 ($P<0.05$).

Results: At the beginning of the study, there was no significant difference between the groups [(mean VAS: 5.84±2.44 vs. 6.2±2.47, P=0.823) and (lesion diameter: 2.48±1.47 vs. 2.34±1.15, $P=0.944$)]. After treatment with CO2 laser, pain level in the experimental group was 1.84±3.24 compared to the control group (5.12±3.02) ($P<0.001$) and the size of the lesion was 0.73±1.19 versus 2.02±1.27 ($P<0.001$). Laser therapy efficiency index was higher than that of local treatment with corticosteroids ($P<0.001$). In recent years, laser irradiation in treating mucocutaneous lesions has shown positive results. The present study showed that laser therapy caused a reduction in lesion size during a 6-month period. Similar findings were reported by Pakfetrat et al who observed a significant reduction of pain and burning following CO2 therapy during 3 months. The mechanism behind lesion improvement in laser treatment is related to the laser power. In previous studies, low-power lasers with low range and different powers were reported to have 25%-85% improvement, while in this study with a 2 W power, 84% improvement was recorded.

Conclusion: Radiation of CO2 laser on OLP lesions that are resistant to local corticosteroids can reduce pain level and lesion size more than corticosteroid therapy.

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ABSTRACT 24

Low-Level Laser Therapy for Facial Dysesthesia

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ABSTRACT

Background: Low-level laser therapy (LLLT) is being used in several conditions because of its non-invasiveness. Facial dysesthesia due to nerve injuries is one of the challenging conditions to treat that has few effective remedies. Using LLLT in nerve recovery is the subject of few studies.

Methods: Twenty-six patients suffering from facial dysesthesia/anesthesia because of trauma or after surgery who were 18-60 years old entered the study. According to the duration of their problems, we divided them into 3 groups: A (trauma less than 7 days old), B (trauma 7-30 days old) and C (trauma older than one month).
The severity of dysesthesia/anesthesia was evaluated in each section using visual analog scale (VAS) and the improvement rate was the percentage of the differences in these scores as: Grade I: less than 10%, Grade II: 10%-30%, Grade III: 31%-60%, Grade IV: 61%-100%. Our laser was InGaArP diode laser (940 nm) made by the American Biolase Company, the power was 0.4 W, the exposure time for each point was 10 s, in continuous mode and the energy density was 5.08 J/cm^2. Patients were irradiated by laser for 10 sessions (3 times a week).

Results: We had 10 patients in group A with a mean improvement rate of 59.5% (SD=26.5047). In group B, we had 7 patients whom mean improvement rate was 35.28% (SD=24.2674). Patients in group C were 9 with a mean improvement rate of 31.55% (SD=16.7191). Comparing between A and B group levels showed the significant difference between them (P=0.037) which group A showed higher improvement rate than B and also the improvement rate of group A was significantly higher than group C (P=0.007). But, despite the better results of group B in contrast with group C, the difference was not significant (P=0.36). Although there are some researches on the effect of LLLT (of red/infrared laser) on paraesthesia or anesthesia, it seems there should be more surveys on the effect of time of referral for the laser therapy. The improvement of patients in group B was better than group C but the difference was not significant statistically.

Conclusion: Laser therapy can improve facial trauma induced anesthesia/dysesthesia, especially in early referral.

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ABSTRACT 25

Effects of Low-Level Laser Therapy on Myofascial Pain Following Temporomandibular Disorders

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ABSTRACT

Temporomandibular (TM) disorders term is applied for many clinical problems involving TM Joint, masticatory muscles and/or relevant structures. Pain, movement limitations, crepitation, abnormal sounds, asymmetric jaw and overall dysfunction are common signs and symptoms among people with TM disorders. Besides, the number one reason for missed work days is musculoskeletal pain that may happen in disorders such as TM problems.

The common therapeutic methods (such as non-steroidal anti-inflammatory drugs, steroid injections, opiate pain medications and surgery) are currently accepted as pain managers .Musculoskeletal symptoms might have their own specific risks when they are applied for myofascial pain following TM disorders.With the predicted epidemic of chronic pain in developed and underdeveloped countries, it is imperative to validate safe and cost-effective techniques for managing painful conditions which would allow people to live active and productive lives. So, any effective methods for pain treatment following TM disorders which have an acceptably low risk-profile and/or cost-effective way might be a preferable selective choice to manage relevant patients.

Low-level laser therapy (LLLT) has been shown effective on inflammation, edema, pain, and it promotes the healing process in a range of musculoskeletal disorders; however, the relevant studies mostly did not focus on TM disorders. The purpose of this presentation is to explain/review the use of LLLT for pain following musculoskeletal TM disorders, the possible biochemical mechanisms of action, and effective doses response curves. The results of the study show that although laser application can be beneficial for TM disorders in different ways, more clinical trials are needed to compare the effectiveness of laser irradiation with the other treatment methods.

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The Effects of Low Level and High Power Laser Therapy in Patients With Trigeminal Neuralgia: A Systematic Review

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ABSTRACT

Background: The efficacy of laser therapy in trigeminal neuralgia (TN) is not clear. According to clinical and neurophysiological studies, TN is a neuropathic condition that should be considered in treatment strategies. TN refers to pain in the nerve distribution regions including maxillary, mandibular and ophthalmic branches. Different treatment protocols are used in acute and chronic phases of TN.

Methods: The English literature published in PubMed, Scopus, Science Direct, Google Scholar, Springer, Cochrane Library, and Web of Science from 2000 until January 2017 was reviewed. All searches were based on main keywords: low-level laser, High power laser, laser therapy, Low-level light therapy and TN.

Results: Of 34 studies, 7 met the inclusion criteria. Five of the 7 studies achieved a high-quality PEDro score (≥8). Two papers were clinical case researches. The pooled effect size for pain variable was –0.7, indicating a large effect of pain relief. In addition, a dose of 6 J/cm^2 and treatments with 830 nm wavelength pulsed GaAlAs lasers can cause large pain relief effects. There is no consensus on sites of laser treatment but trigger points and path of nerve radiations were the most common effective sites. The usual time of laser therapy was about 15 minutes. Both low level and high power lasers were effective in relieving pain in TN.

Conclusion: There are few studies about the effects of laser therapy in TN. Although many of them showed improvements in symptoms, the intervention protocols were controversial and inconsistent. Long-term effects of laser therapy did not show in any of these studies. The short-term effects of laser therapy in TN are significant. Nevertheless, the exact protocol of laser treatment is still unknown and the roles of dosage and power and site of treatments need more investigations.

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ABSTRACT 27

Comparison of the Effect of Low-Level Laser Therapy With Alvogyl on the Management of Alveolar Osteitis

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ABSTRACT

Background: This study investigated the efficacy of low-level laser therapy (LLLT) for managing alveolar osteitis (AO).

Methods: Sixty patients with alveolar osteitis of mandibular third molars were randomly divided into 3 groups. In group 1, socket irrigation was followed by alvogyl placement, and the treatment was repeated 48 hours later. In group 2, socket was irradiated with a low power red laser for 3 consecutive days (200 mW, 30 seconds on each of the buccal and lingual surfaces and 30 seconds at the middle of the socket, 6 J per area). The subjects in group 3 underwent treatment with a low power infrared laser with the same parameters as group 2. A visual analogue scale (VAS) was used to record the degree of pain at the morning (T0, before intervention) and at 6 (T1) and 12 (T2) hours later for 3 days.

Results: Pain was significantly lower in the alvogyl group than the other groups at T1 and T2 points on day 1 and at T0 and T1 points on day 2 ($P<0.05$). At T2 point on day 2 and on day 3, VAS became significantly lower in the red laser group compared to the other groups ($P<0.05$). The infrared laser was not more efficacious than the other groups at any of the treatment intervals, but it reduced VAS to an acceptable level.

Conclusion: LLLT displayed good results in this study for treatment of alveolar osteitis and should be further investigated as an alternative to alvogyl for AO management.

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ABSTRACT 28

Photobiomodulation in Nerve Injuries

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ABSTRACT

Background: Nerve tissue injuries may occur during various dental and routine surgical procedures that result in partial or total loss of motor or sensory function in the involved segments. Depending on the type and severity of the injury the treatment approaches may vary. Despite the progress in understanding the pathophysiology of peripheral nerve injury and regeneration, as well as advancements in microsurgical techniques, peripheral nerve injuries are still a major challenge for reconstructive surgeons. The aim of this review study is to investigate the efficacy of low-level laser therapy (photobiomodulation) as one of the treatment approaches in nerve regeneration.
Methods: An electronic search was performed on relevant English articles up to January 2017 in the PubMed, Scopus, and Google Scholar databases.
Results: The literature pointed out three main goals of photobiomodulation in nerve injuries: acceleration of injured nerve tissue regeneration, stimulation of adjacent or contralateral nerve tissues, causing them to play the role of the sectioned nerve and biomodulation of the nerve response leading to the normality of the action potential threshold.
Conclusion: Based on the encouraging results of this review, photobiomodulation can be a novel approach in nerve regeneration considering the correct selection of nerve injuries cases and appropriate laser parameters.

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ABSTRACT 29

Free Space Planar Fluorescence Imaging System for Screening Early Oral Cancer

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ABSTRACT

Oral cancer is an important global health problem. There is an urgent need for improved methods to detect oral cancer and its precursors, because early detection is the best way to reduce oral cancer mortality and morbidity. Fluorescence imaging has been shown to be an effective alternative method for screening and diagnosis of pre-cancers in several organ sites including the oral cavity, uterine cervix, lung, and skin. Several groups have shown that the examining the oral cavity under a fluorescence excitation light source can overcome some of the detection limitations associated with the standard white-light examination.

In this work, we describe a planar imaging system that has the capability to visualize and take images from oral tissue in multiple imaging modalities including fluorescence, white-light reflectance, and orthogonal polarization reflectance. Images obtained with the system in-vivo demonstrate that it is an attractive technology to explore for oral cancer screening in low-resource environments where clinical expertise is often unavailable.

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ABSTRACT 30

New Findings on Lasers in Preventive Dentistry

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ABSTRACT

The first laser applied in dental research was a ruby laser which was in visible light range. It was used successfully for prevention of subsurface demineralization. With the introduction of different wavelengths of lasers with different materials, laser application is becoming a complementary method or even a substitute to conventional methods of caries prevention in modern dentistry. Studies have reported synergistic effects of laser with fluoride on caries prevention; although there is no agreement on the most effective type of laser and laser parameters for caries prevention.

The lasers available for caries prevention are CO_2, Er:YAG, Er,Cr:YSGG, Nd:YAG, Argon, and diode lasers. Each laser increases tooth resistance to demineralization through specific irradiation parameters and affects tooth substrate via different mechanisms.

Several mechanisms have been reported for the effect of laser on caries prevention. The most accepted theory for the effect of CO_2 laser on enamel resistance to caries is carbonate loss from the apatite crystal, leaving the mineral more acid resistant. This theory is called organic blocking, which happens at temperatures lower than 400˚C. This theory is also present for other types of lasers. Enamel solubility is also related to the loss of water content, increase in hydroxyl ions, and formation of pyrophosphate. Creation of microspaces on the tooth surface is another mechanism for caries resistance. During acidic challenges, the calcium and phosphate ions detached from the tooth surface trap into these microspaces instead of been released into the oral cavity, and are kept as reservoirs for further remineralization phases.

The organic matrix of enamel is also important in the laser caries preventive effect. After heat treatment of enamel surface by laser irradiation, the organic matrix is removed and more highly mineralized apatite crystals are left with blocked interprismatic spaces.

Considering the diversity of the research subjects, lasers, and parameters in previous studies, it would be more beneficial for clinical application if future studies focus on determining the exact parameters of each laser for different applications. Comparison of different lasers in similar experimental conditions, determining the effect of fluoride in combination with laser treatment, comparing different compositions of fluoride, and also evaluation of the advantages and disadvantages of fissure sealant therapy with lasers or even focusing on changing oral microbial flora in high risk groups would all guide us to more exact information and better lead the studies on laser technology to clinical practice. I will try to use this opportunity to discuss these concepts.

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ABSTRACT 31

Epigenetics Assisted Photodynamic Therapy

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ABSTRACT

Epigenetics is the study of heritable alterations in gene expression that are not accompanied by the corresponding change in DNA sequence. Three important epigenetic processes regulate gene expression at the level of chromatin including nucleosomal remodeling, DNA methylation, and histone covalent modifications. Chromatin is a highly dynamic structure composed of DNA and protein (histone and non-histone proteins). Histone amino-terminal regions can undergo modification by acetylation, methylation, phosphorylation, ubiquitylation, sumoylation and ADP ribosylation. The enzymes histone acetyl transferase (HAT) and histone deacetylase (HDAC) control the acetylation level of histones and thereby alter gene expression.

Many cancers display molecular alterations that change the balance between HAT and HDAC activity. HDACs exert a pro-oncogenic effect by silencing genes involved in differentiation, apoptosis and cell cycle arrest. Therefore, the inhibition of HDACs is a target for the development of novel anticancer therapy. Histone deacetylase inhibitors (HDACIs) show anticancer activity by promoting acetylation of histones. The effect of HDACI is different such as cell cycle arrest, inhibit DNA repair, and induce apoptosis.

Photodynamic therapy is a form of radiation therapy that is composed of three important parts: a photosensitizer, molecular oxygen and light at a specified wavelength for producing reactive oxygen species (ROS), particularly singlet oxygen in tumor cells. The tumor cells would be destroyed by apoptosis and/or necrosis induced by ROS, achieving the goal of local treatment with minimum invasion.

Although the role of photodynamic therapy on the epigenetic process such as DNA methylation and histone deacetylase is unknown, recently some studies demonstrated that the light could control epigenetic regulator such as HDAC enzymes. Eventually, a combination of photodynamic therapy with epigenetic may be a novel approach for a more tumor-selective treatment.

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ABSTRACT 32

Dental Laser Applications in Esthetic Dentistry: Clinical Cases

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ABSTRACT

Background: Nowadays, there is a great interest in using dental lasers as a new technology in different fields of dentistry representing an adjunct or alternative to conventional treatments in order to improve treatment outcomes or patients' convenience. On the other hand, there is a great attitude towards esthetic and cosmetic treatments from patient's side and beautification of smile is becoming an everyday requirement in dental practice1. This presentation is trying to show how different dental laser wavelengths could be used safely in esthetic dentistry and how it could be possible to save time and money in dental clinics by using this new modern technology.
Methods: A total of 10 clinical cases with esthetic demands treated with dental lasers were included, the data on age, gender, laser wavelength, laser irradiation settings, healing time, patient satisfaction, and post-operative pain were all recorded.
Results: From a clinical point of view, the application of dental lasers for esthetic treatments such as bleaching, gingival depigmentation, and esthetic gingivectomy had very good results regarding patient comfort, post-operative healing time, post-operative complications, and tooth hypersensitization. In one case bleached with Er:YAG laser, the patient complained of dull pain in the right lateral incisor for 24 hours after treatment.
Conclusion: Dental Lasers as a new modern technology can be used safely in different esthetic procedures. However, it should be kept in mind that selection of proper wavelength and correct settings are key factors for achieving desirable results.

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ABSTRACT 33

The Role of Femto Second Laser in Dentistry

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ABSTRACT

Tooth-tissue ablation has been explored using holmium:YAG and Erbium:YAG lasers, excimer lasers, and others. The results, however, have been unimpressive, as a result of thermal side effects and long processing times. Using ultrafast laser pulses for this application was first proposed in 1993. Ultrafast-laser/tissue interaction with high peak intensity favors a rapid plasma formation and, consequently, the transformation of the deposited energy into material ionization and ejection rather than heat transfer to the environment, so that side effects such as cracks and heat conduction to the nerves are greatly reduced. Pico- and femtosecond lasers have successfully been used in this area.

Recently the researchers generated femtosecond-laser (FS) pulses by a straightforward approach without chirped-pulse amplification (CPA). A commercial ytterbium: glass laser tunable from 1030 to 1050 nm and emitting 300 fs pulses with 1 nJ output pulses and also a beam quality M^2 of 1.2. Such a femtosecond laser enables the dentist to focus its probe tip on its target at such a precise speed and level of efficiency that surrounding areas are not affected.

In dentistry, the laser could treat tooth decay without compromising the tooth's structure and provide a much more efficient and harmless method of treatment for patients.

Femtosecond lasers are extra-fast, extra-intense lasers that have unique characteristics for dental application due to their minimizing thermal damage and changes of biochemical structures of surrounding tissues. Recent studies have shown, that the FS laser will likely provide unparalleled advantages in painless dental ablation/drill and caries removal/prevention. The minimal collateral damage during the FS laser treatment, consequently, will ensure fast recovery. Dental burs currently used in dental preparations, such as carbide and diamond burs, are known to cause significant discomfort and pain during the process, and post-operative sensitivity. But FS laser, has high potential to deliver painless and vibration-free treatment of tooth, including caries removal, with high precisions. In addition, the FS laser may also be an excellent tool for caries prevention. In this article we will describe how to create ultra-short FS pulses and also how effective they are in dentistry.

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ABSTRACT 34

Comparison of Ultrasonic Device Use Alone and in Combination With Nd:YAG Laser for Scaling and Root Planning on Root Surface Roughness on Periodontally Diseased Extracted Teeth

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ABSTRACT

Background: A smooth root surface has been considered as the ultimate goal of the initial phase of all periodontal treatments. Therefore, scaling is a prerequisite for every periodontal treatment. The objective of this study was to compare the ultrasonic device use alone and in combination with Nd:YAG laser for scaling and root planning on root surface roughness of periodontally diseased extracted teeth.

Methods: This in vitro study was conducted on 26 single-rooted maxillary and mandibular human teeth extracted for periodon¬tal reasons. The specimens were mounted in stone blocks after cutting off in apico-coronal direction into two sections with a carbide disc and water coolant. Scaling and root planning was done with an ultrasonic device on both sections. One of the randomly selected sections of each specimen was irradiated with Nd:YAG following scaling and root planning. Scanning electron microscopy (SEM) was used to assess the surface roughness. Microphotographs were assessed and scored under the magnification of ×100.

Results: The mean depth of craters in the control group was 21.53 µm versus 30.84 µm in the test group. Adverse side effects like crack were not seen in the control group, but in the test group, 53.8% of specimens displayed crack. The difference between test and control group's crater depth was significant ($P<0.05$).

Conclusion: The results of this in vitro study suggest that Nd:YAG laser used with the above-mentioned settings in combination with ultrasonic device resulted in physical changes like crater and crack on the root surface.

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ABSTRACT 35

Comparison of Low-Level Laser Therapy Plus Topical Corticosteroid Therapy With Topical Corticosteroid Therapy Alone in Treatment of Recurrent Aphthous Stomatitis

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ABSTRACT

Background: Recurring aphthous stomatitis are common and painful ulcers of the mouth. Many different treatment methods have been used to reduce pain intensity and remission time. Common treatment consists of topical corticosteroid with anesthetic and lining material. In some studies, the efficacy of low-level laser therapy compared with topical corticosteroid and laser placebo were studied. In this research, for the first time, low-level laser therapy plus topical corticosteroid was compared with topical corticosteroid alone for treatment of recurrent aphthous stomatitis.

Methods: In this single-blinded clinical trial, 30 patients with early (first 48 hours) minor aphthous ulcers based on the inclusion and exclusion criteria and ethical issues, were randomly distributed in two 15-person groups; in one group of low-level laser plus topical corticosteroid and in the other group topical corticosteroid alone were used. All the patients received standard treatment, diphenhydramine syrup as mouthwash for one minute before food consumption and topical corticosteroid used as a combination of 3 betamethazone ampoules dissolved in magnesium syrup 3 times per day after meal and one-minute gargling. This treatment was continued up to ulcers healing. For the laser group, low-level laser therapy was done using diode 660 nm (LT-R , Behsaz Gostar, Iran, class IIIB) 4 J/cm^2, 100 mW, 0 Hz and 40 seconds in 2 sessions (first and third day), perpendicular to the lesion and nearly in contact mode. Both groups were examined every day and remission time (clinical disappearing of lesions) and pain intensity according to visual analogue scale (VAS) were compared. Data were analyzed using SPSS 20 software package and statistical independent *t* test and Mann-Whitney.

Results: Mean of VAS, on the fourth day of examination in the topical corticosteroid plus low-level laser group was significantly lower than in the topical corticosteroid alone group ($P=0.04$).

The average lesion size at the fourth day of examination in the low-level laser plus topical corticosteroid group was significantly lower than in the topical corticosteroid alone group ($P=0.02$).

The difference in pain-free ($P<0.001$) and complete clinical healing ($P<0.001$) in the laser group was significantly lower than the standard treatment group.

Conclusion: The results of the research showed that low-level laser plus topical corticosteroid is significantly more effective in reducing pain intensity and recovery from recurrent aphthous stomatitis in comparison with topical corticosteroid alone.

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ABSTRACT 36

Optical Spectroscopy as Noninvasive Technology in Oral Diseases Diagnosis

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ABSTRACT

Oral cancers are considered as common malignancies worldwide, thus early detection and treatment seem to be vital for better survival. In other words, the main reason for poor survival rate is the fact that most of the oral cancers are not diagnosed until the advanced stage. Early detection of the oral suspicious and precursor lesions may be the most effective means to improve clinical outcome and cure most patients.

A number of optical modalities have been developed to assist clinicians in detecting oral mucosal abnormalities and differentiating benign lesions from malignancies. Some of the common optical technologies are imaging such as autofluorescence, fluorescence Imaging, laser confocal endomicroscopy, optical coherence tomography (OCT), and confocal reflectance microscopy which have their own special role in clinics for early detection. Among all optical methods, optical spectroscopy methods like Raman and reflectance spectroscopy are promising technologies and offer several advantages over conventional approaches, including objectivity, speed, cost, label-free, and noninvasiveness.

The basis is that diseased tissues promote cellular and biochemical changes, which are termed tumor markers; these changes cause variations in the optical spectrum obtained from diseased tissues that can be compared with the baseline spectrum of normal tissues for differentiation. The spectral changes are unique and specific for the given tissue sample, are called fingerprints and thereby can be tracted in spectrums. Here, we review the use of optical spectroscopy and discuss its application for noninvasive diagnosis of oral diseases.

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ABSTRACT 37

Effect of Low-Level Laser Therapy on Otalgic Pain and Tinnitus Related to Temporomandibular Joint

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ABSTRACT

Background: Temporomandibular disorders are some of the most common reasons for patients to attend dental clinics. According to the complex anatomy of the temporomandibular joint and its proximity to ear, joint disorders have been known as some the major reasons for aural symptoms such as tinnitus, otalgia, ear fullness and vertigo. The aim of this study is to examine the effectiveness of low-level laser therapy (LLLT) in treating tinnitus referred from temporomandibular joint (TMJ).

Methods: This is a randomized, double-blind placebo-controlled trial. Patients with subjective tinnitus and otalgia as their main symptoms were recruited into the study from outpatient clinics in Isfahan private ear, nose and throat clinics. After ENT examination, clinical tests according to each patient's conditions, patients with tinnitus and otalgia due to Temporomandibular joint were studied. The recruited patients were randomized into a laser group (16 subjects) and control group (17 subjects), using the off-mode laser for the second group.

In the laser group, patients were treated with LT-R laser (Behsaz Gostar Company, Iran), for 4 weeks and 12 sessions. Patients received laser in the outer ear canal with a wavelength of 660 nm, 40 mW, 0 Hz, for 200 seconds with a special acupuncture probe at a dose of 2.9 J/cm^2. Besides, patients received laser with 100 mW, 0 Hz, and 8 J/cm^2, without probe, directly and almost perpendicular to the temporomandibular joint and sensitive muscular regions. The same protocol was followed for the control group, but the laser was in off-mode. The tinnitus intensity was evaluated by THI (tinnitus handicap inventory) and VAS (visual analog scale) before therapy commencement, immediately after session 6, after the completion of session 12 of the therapy and also after one month follow up. Parried T-test, Wilcoxon, man-Whitney and Friedman tests were used for data analysis.

Results: Amongst 33 patients between 15 to 60, with a mean age of 38.94±11.86 in the laser group was, and 37.12±11.60 in the control group, the study results showed that in laser group, both THI and VAS figures significantly decreased (P=0.004). However, in the control group, pain intensity and tinnitus have not shown any significant difference in the 4 time spans (P=0.641). All patients were compared at the four phases. Although results in all four phases were significant, they have shown that the mean figures of both tests after one-month follow-up have reached scores close to the commencement of treatment.

Conclusion: The study has shown that low-level laser therapy has had useful and advantageous effects on patients who suffer from referral tinnitus and otalgia. But the long-term effects of laser treatment are suspect.

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ABSTRACT 38

Photodynamic Therapy for Oral Lichen Planus

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ABSTRACT

Oral lichen planus (OLP) is categorized as a chronic, vesiculobullous disease, often manifesting as painful oral vesicles and ulcerations. It is a cell-mediated immune condition of unknown etiology in which T lymphocytes accumulate beneath the epithelium of oral mucosa triggering differentiation of stratified squamous epithelium resulting in hyperkeratosis and erythema with or without ulceration.

Currently, no definite cure has been introduced for lesions of OLP. Several treatment modalities have been trialed, primarily aimed at reducing the length and severity of symptomatic outbreaks.

Conventionally, topical steroids are considered as first-line agents for the treatment of symptomatic active lesions often with suboptimal results. Other agents have been applied experimentally to overcome lesion resistant to topical steroids, including retinoids, azathioprine, cyclosporine, tacrolimus, and mycophenolate mofetil. These agents are accompanied by several serious side effects limiting their long-term use.

Photodynamic therapy (PDT) has been recently introduced for the treatment of refractory OLP lesions to medical therapy. This technique applies a photosensitivity compound, selectively accumulated in target cells, followed by local irradiation of the lesions with visible light. The combination of above two nontoxic elements, in the presence of oxygen results in selective photodamage and cell death.

Our goal is to review the results of the application of PDT in the treatment of certain OLP cases, with special consideration of its impact on patient's quality of life, number, and duration of recurrences.

This review study approves the utility of PDT in OLP cases, showing a significant decrease in healing time of lesions particularly in OLP patients with systemic diseases like diabetes mellitus.

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ABSTRACT 39

Evaluation of Nd: YAG Laser Irradiation Effect on the Microtensile Bond Strength and Microleakage in Class V Composite

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ABSTRACT

Background: Nowadays, the main focus of dental studies is on adhesive dental materials; because the clinical long-term success of bonded restorations depends more on marginal microleakage minimization and microtensile bond strength enhancement. Therefore, the aim of this study was the evaluation of Nd:YAG laser irradiation effects on the microtensile bond strength and microleakage in class V composite restoration.

Methods: In this in vitro-experimental study, standard class V cavity was prepared on both lingual and buccal surfaces of 30 premolar teeth. For the evaluation of microtensile bond strength, 30 teeth were divided randomly into two groups A, B (n=15): A) primer + adhesive (Clearfil TM SE Bond), B) primer + laser Nd:YAG (1064 nm, 60 mJ, 15 Hz, 0.9 W, 20 s), and for the evaluation of microleakage, 30 teeth were divided randomly into 2 groups C, D (n=15): C) primer + adhesive (Clearfil TM SE Bond), D) primer + laser Nd:YAG (1064 nm, 60 mJ, 15 Hz, 0.9 W, 20 s). Then, restoration was completed with Z250 composite. Data analyzing was performed using 16 SPSS software. Non-parametric Wilcoxon and Mann-Whitney U tests for microleakage comparison and T-test were used for microtensile bond strength at 0.05% significance level.

Results: According to non-parametric Mann-Whitney U, microleakage scores had significant differences before and after laser irradiation on intended adhesive ($P=0.049$). Also, based on Wilcoxon test results, total microleakage scores of occlusal margins in both groups were statistically significantly different in comparison with gingival margins ($P=0.005$). T-test results showed that there was a significant difference between study groups on microtensile bond strength ($P=0.016$). According to the results of the study, we saw marginal microleakage reduction after Nd:YAG laser irradiation with mentioned characteristics on self-etch primer. Also, microtensile bond strength of the irradiated group showed a significant enhancement in comparison with the control group.

Conclusion: This study findings showed that Nd:YAG laser irradiation on self-etch primer before bonding have significant effect on marginal leakage reduction and microtensile bond strength enhancement of 6th generation adhesive in class V cavities.

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ABSTRACT 40

The Clinical and Physical Aspects of NTCLT (Non-Thermal CO2 Laser Therapy) as a Photobiomodulative Pain Relieving Approach in Oral Lesions: An Update

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ABSTRACT

Background: Non-thermal CO2 laser therapy (NTCLT) is a novel photobiomodulative approach used for pain reduction of some oral lesions. In our studies series, we have evaluated the pain-relieving effects of NTCLT in some oral lesions for example; recurrent aphthous stomatitis (randomized controlled clinical trial), oral lesions of pemphigus vulgaris (before- after clinical trial), oral aphthous ulcers of Behcet disease (case series), chemotherapy-induced oral mucositis (patchy OM, before- after clinical trial), and graft versus host disease (case report).

Methods: In order to use the CO2 laser as a photobiomodulative laser for NTCLT, the CO2 laser beam (power: 1 W) was irradiated through a thick layer of transparent, non-anesthetic gel with high water content. In addition, the CO2 laser is operated with a de-focused hand piece, scanning rapidly over the lesion with circular motion.

Results: The severity of contact and non-stimulated (non-contact) pain declined immediately and significantly after NTCLT ($P < 0.001$). The procedure was pain-free and no kind of analgesics was required. Following NTCLT, there were no visible thermal complications such as destruction, ablation or irritation of the oral lesions. In addition, the results of thermometry, powermetery, and some other physical studies confirmed the non-thermal nature of NTCLT.

Conclusion: The results of these trials propose that a single session of NTCLT can relieve pain in oral lesions of recurrent aphthous stomatitis, pemphigus vulgaris, patchy oral mucositis (chemotherapy induced) immediately and significantly without any visible thermal complications. The physical studies have confirmed the non-thermal nature of NTCLT.

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Poster Presentations

ABSTRACT 41

Laser and Myofascial Pain of Head and Neck

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ABSTRACT

Myofascial pain syndrome (MPS) is one of the most prevalent and significant health problems which causes diminished function and impaired quality of life. Myofascial pains are caused by myofascial trigger points which are characterized by discrete hyper contracted and sensitive foci within muscles and/or connective tissues. Clinical manifestations of these trigger points in the head and neck region present as headache, neck pain and temporomandibular dysfunction.

MPS treatment is challenging, multidisciplinary, and still lacks a clear remedy. Different treatment options include physical therapy, medications, trigger point injection, acupuncture, chiropractic management, transcutaneous electrical nerve stimulation, and laser therapy. Laser is an effective modality in treating many acute and chronic musculoskeletal syndromes, it improves local microcirculation, oxygen supply, removes waste products, and increases mediators of pain inhibition. The advantages of laser, like, non-invasiveness, ease, short-term applications and fewer side effects make it favorite among clinicians.

Numerous researches have been conducted to evaluate the efficacy of laser therapy for treatment of MPS. Different laser wavelengths, intensities, densities, dosages, and treatment intervals have been used in various animal and human studies. Laser therapy seems to be effective in pain relief, improvement of function and quality of life in patients with MPS and could be used as one of the treatment modalities.

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ABSTRACT 42

Effect of Low-Level Laser Therapy on Dental Pain Induced by Separator Force in Orthodontic Treatment

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ABSTRACT

Background: Patients undergoing orthodontic treatment experience varying degrees of pain with separator insertion. A survey of patients' attitude towards orthodontic treatment revealed that pain was the most discouraging factor related to their treatment. Moreover, it was the highest ranking reason for wanting to discontinue care. The purpose of this study was to determine the effect of low-level laser irradiation on dental pain induced by forces from separators in orthodontic treatment.

Methods: This study was an experimental clinical trial. Twenty-nine patients were recruited for this research. Low-level laser irradiation was applied on one half of the maxillary and mandibular arches- for 5 days. The opposite half of the arches was considered the control group. The abone between the second premolars, first molars, and second molars. Pain perception was evaluated with a standardized questionnaire that was answered by patients before and after laser irradiation. Data was analyzed by Wilcoxon and Friedman test. P value ≤0.05 was considered significant.

Results: The highest pain level was reported at day 1 following separator placement and decreased gradually until day 5. At day 4 and 5, the pain intensity was lower in the laser group than in the control group with; however, this finding was not statistically significant. At day 1 and 3, with the pain intensity was higher in the laser group than in the control group; however, it was not statistically significant. At day 2, the pain intensity was lower in the laser group than in the control group and was statistically significant.

Conclusion: Our findings suggest that there is no statistically significant difference in pain by using low-level laser irradiation.

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ABSTRACT 43

The Effect Of Low-Level Laser Therapy on Alleviating Pain and Swelling After Mandibular Third Molar Surgery

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ABSTRACT

Background: This study was conducted to assess the effect of low-level laser therapy (LLLT) on managing pain and swelling after removal of impacted lower third molars.

Methods: This randomized, double-blind, split-mouth designed study included patients presenting 2 symmetrically impacted mandibular third molars. One side of each participant was randomly assigned to the laser treatment and the other side served as placebo. LLLT was performed by intraoral application of a 660 nm laser (200 mW, 6 J/point, 4 points) followed by extraoral application of an 810 nm laser (200 mW, 6 J/point, 3 points). Irradiation from the 810 nm wavelength was repeated on days 2 and 4 after the operation. On the placebo side, the treatment protocol was similar to the experimental side but with laser simulation. The main outcomes were measuring the degree of pain over 7 days and calculating the edema coefficients on days 2, 4 and 7 after the operation. The data were analyzed using generalized linear models to determine the effect of group and time on pain level and edema coefficients.

Results: The final sample consisted of 40 patients. Pain level was significantly lower in the laser than in the placebo side at all time points over the experiment ($P<0.05$). Swelling was significantly lower in the laser than in the placebo group on days 2, 4 and 7 after operation ($P<0.05$).

Conclusion: LLLT proved to be effective in reducing the intensity of pain and swelling after removal of impacted third molars and could be recommended to alleviate patients' symptoms following operation.

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ABSTRACT 44

Efficacy of Low-level Laser Therapy on Bell's Palsy: Literature Review

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ABSTRACT

Background: Low-level laser therapy (LLLT) in medicine has been known for almost forty years since the invention of lasers. It can reduce pain, inflammation, and edema, promote wound, deeper tissues and nerves healing, and prevent tissue damage, and improve cellular function via light emitting diodes. The purpose of this paper is a review of the clinical usage and efficacy of these lasers in Bell's palsy.

Methods: This review will cover related articles that were available in PubMed, Google Scholar, Science Direct from January 2010 until January 2014 with keywords: LLLT, Bell's palsy, medical treatment.

Results: In most investigations, LLLT was associated with significant effectiveness in nerve injury recovery while a few studies are controversial.

Conclusion: LLLT begets a painless medical treatment alternative without any side effects that can be used on any type of patient, similar to drugs.

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ABSTRACT 45

A Comparative Study on Enamel Surface Alterations After Laser-Assisted Bleaching Using Diode 810 nm and Diode 980 nm

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ABSTRACT

Background: Nowadays tooth bleaching is a conservative and well-accepted treatment procedure for discolored teeth. Laser is a novel option utilized to activate this process. Using this method, the surface morphology of enamel and enamel crystals have been affected. The purpose of this study was to investigate the effect of laser-assisted tooth bleaching with diode 810 nm (1.5 W), diode 980 nm (1.5 W) on the surface morphology of tooth enamel using X-ray diffraction (XRD) and scanning electron microscopy (SEM).

Methods: For the study, 10 sound human premolars extracted for orthodontic reasons were selected. After cutting off their roots, their crowns were cross-splitted mesiodistally, the teeth were then randomly divided into five groups: Bleaching with Heydent JW and diode 810 nm, bleaching with Heydent JW and diode 980 nm, bleaching with Opalescense Xtraboost and diode 810 nm, bleaching with Opalescense Xtraboost and diode 980 nm, Control group. Bleaching agents were painted on specimens's buccal surfaces with a uniform thickness of 1-2 mm. Each specimen was irradiated for 30 seconds, then rest for 1 minute and the same procedure was repeated 3 times.

Results: Laser irradiated groups showed an increase in enamel crystallinity based on XRD analysis, and less negative effects on enamel surface through SEM observations, compared with conventional bleaching. The enamel surface alterations in SEM images were significant in the conventional bleaching (control) group. The results indicated a more favorable improvement in Opalescense Xtraboost gel treated teeth combined with both diode laser irradiation, through SEM as well as XRD analysis. XRD analysis also showed more increase in enamel crystallinity of Opalescense Xtraboost gel treated teeth, in comparison with Heydent JW gel treated teeth, along with laser irradiation. Also, fewer surface alterations were observed through SEM in these surfaces. In SEM images, enamel degradation and deep cracks were not observed in any groups.

Conclusion: Diode laser irradiation during tooth bleaching not only increased enamel crystallinity but also protected the enamel surface structure. According to this study, bleaching with Opalescense Xtraboost gel accompanied by diode laser irradiation could be a better choice for office-bleaching treatment.

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ABSTRACT 46

The Effect of the Low-Level Laser in the Treatment of Xerostomia: Reports on 4 Cases

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ABSTRACT

Background: Xerostomia is not a disease itself. The condition can be associated with systemic diseases, medications or radiation therapy. Current treatments of dry mouth have deficiencies and limitations or just have short-term impact. The aim of this study was to evaluate the effect of diode laser 980 nm to treat dry mouth. Diode laser 980 nm is more applicable in dentistry.

Case Reports: Four patients with oral dryness (subjective or objective) volunteered to participate in this study. The participants' xerostomia was evaluated by Fox questionnaire and the amount of their saliva and anxiety were studied by Cattell questionnaire. The patients treated were as follows: (1) a 46-year-old man who wore denture without any systemic diseases and drug consumption (2) a 58-year-old woman with diabetes, hypertension, hyperlipidemia, and anxiety (3) a 39-year-old woman with feeling of dry mouth and normal saliva rate suffering from diabetes (4) a 75-year-old man with a history of thyroid cancer and radiotherapy. Diode laser 980 nm (low-level laser) was used on the submandibular, parotid, and sublingual glands bilaterally every other day for 10 sessions.

Results: All patients, except the patient with a history of radiation therapy, showed improvement after treatment with diode laser 980 nm (10 sessions). There were not any special side effects during treatment. This effect can be induced via changes in saliva rate or concentration or its enzymatic activity.

Conclusion: Low-level laser therapy with diode laser 980 nm can be mentioned as an alternative treatment for xerostomia when salivary gland function is suitable. More research is needed in this area.

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ABSTRACT 47

Laser Application in Treatment of Oral Mucosal Vascular Lesions

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ABSTRACT

Benign vascular lesions of the oral mucosa consist of hemangioma and vascular malformations. Hemangiomas are benign endothelial tumors appearing a few weeks after birth, followed by a self-limited replicative course.
Vascular malformations may be of arterovenous, venous, lymphatic, or capillary origin. These are congenital, lifetime structural anomalies with normal endothelial turnover which may cause ulceration, hemorrhage, or oral malfunction.
Traditional treatment may be with pharmacologic agents such as steroids or beta blockers, or with procedures such as sclerotherapy, embolization, and cryosurgery with liquid nitrogen or knife surgery.
A new perspective in the treatment of these lesions is laser therapy which may be beneficial in operating on a more precise border, with less need for local anesthesia, less bleeding risk, shorter operation time, followed by more rapid healing and less post-operative pain.
The main target in laser therapy for vascular lesions is the hemoglobin. Therefore it is advisable to use a laser which wavelength is mostly absorbed by hemoglobin such as KTP, CO2, Diode, PDL, Nd-YAG & argon.
Laser therapy techniques include excision biopsy (EB), transmucosal thermo coagulation (TMT) and intralesional photocoagulation (ILP), each having its own benefits and risks.
EB allows to perform histologic examination, meanwhile, there's the possibility of scar formation and hemorrhage.
TMT is a remarkably safe procedure since the laser beam targets the lesion from 2-3 mm above without focusing on a single spot. Thus creating fewer complications during and after application.
ILP is also a less invasive procedure compared with EB. Laser therapy is an effective advisable option in the treatment of oral vascular lesions. Diode is the most applicable laser due to its remarkable absorption by Hb, low cost, ease of application and great penetration into tissues. The regular settings for diode use in these lesions are 808-810 nm, 3-4 W, in a continuous mode.
Laser operation site is completely healed after 1-3 weeks. No patient suffers post-operative complications such as excessive pain, hematoma formation, infection and harm to vital structures. Also unlike conventional surgery, there is no need for suture. Only those with extensive lesions have been complicated by swelling lasting for 1 week afterward.

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ABSTRACT 48

Synergic Phototoxic Effect of Visible Light or Gallium-Arsenide Laser in the Presence of Different Photosensitizers on *Porphyromonas gingivalis* and *Fusobacterium nucleatum*

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ABSTRACT

Background: According to the development of resistant strains of pathogenic bacteria following treatment with antimicrobial chemotherapeutic agents, alternative approaches such as lethal photosensitization are being used. The aim of this study was to evaluate the effect of visible light and laser beam radiation in conjugation with three different photosensitizers on the survival of two main periodontopathogenic bacteria including *Porphyromonas gingivalis* and *Fusobacterium nucleatum* in different exposure periods.
Methods: In this in vitro prospective study, strains of *P. gingivalis* and *F. nucleatum* were exposed to visible light at wavelengths of 440 nm and diode laser light, gallium-arsenide, at wavelength of 830 nm in the presence of a photosensitizer (erythrosine, curcuma, or hydrogen peroxide). They were exposed 1-5 min to each light. Each experiment was repeated 3 times for each strain of bacteria. Data were analyzed by two-ways ANOVA and least significant difference post-hoc tests. $P < 0.05$ was considered as significant. After 4 days the colonies were counted.
Results: Viability of *P. gingivalis* was reduced 10% and 20% subsequent to exposure to visible light and diode laser, respectively. The values were 65% and 75% for *F. nucleatum* in a period of 5-minute, respectively.
Conclusion: Exposure to visible light or laser beam in conjugation with the photosensitizers suspension caused significant reduction in the number of *P. gingivalis* in duration of 5-min, suggesting a synergic phototoxic effect. However, the survival rate of *F. nucleatum* following the exposure to laser with hydrogen peroxide, erythrosine and rhizome of *Curcuma longa* (curcumin) after 5-minute was 10%, 20% and 90% respectively.

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ABSTRACT 49

Influences of Low-Level Laser Therapy on Cell-Based Bone Regeneration: A Systematic Review

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ABSTRACT

Background: Low-level laser therapy (LLLT) also known as photobiomodulation, is a treatment that uses low-level lasers or light-emitting diodes (LEDs) to change cellular function and is a clinically well-accepted tool in regenerative medicine and dentistry. Considering the variety of laser, exposure, cells and study types, the exact effects of LLLT seems to be unclear. The aim of this study was to review the data published in the field of the effects of low level laser therapy on proliferation and differentiation of the cells contributing in bone regeneration.
Methods: To access relevant articles, an electronic search in PubMed was conducted from 2001 to April 2014. Search strategy and study selection were conducted according to PRISMA guidelines. The full texts of potentially proper articles were obtained for final assessment according to the exclusion and inclusion criteria.to
Results: 240 articles were found from January 2001 to December 2016. Following the initial screening of titles and abstracts as well as the final screening of fulltexts, 22 articles completely fulfilled the inclusion criteria of this study. Wavelength used in LLLT irradiation varied between 600 to 1000 nm with an energy density of 0.04–60 J/cm^2. Although almost all studies agreed on getting positive effects from LLLT, some had opposing results.
Conclusion: Low level laser with low-energy density range appears to exert a biostimulatory effect on bone tissue which enhances osteoblastic proliferation and differentiation on cell lines used in in vitro studies. Despite the fact that many researches have been recently done on the effects of LLLT on different cell lines, without knowing the precise mechanism and effects, we are not able to offer a clinical treatment protocol. This paper is a beginning to help further progress and extend practical use of LLLT in future.

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ABSTRACT 50

Study of Inorganic Antioxidant Compound Assisted Low-Level Laser Therapy on Human Breast Cancer Cells

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ABSTRACT

Background: Cancer is a major burden of disease worldwide. In many countries, cancer ranks the second most common cause of death following cardiovascular diseases. Breast cancer is considered as one of the main causes of death among women in recent years. The treatment and prevention of cancer have been mentioned by many researchers. Oxidative stress plays an important role in the pathogenesis of numerous disorders and pathophysiological processes including cardiovascular diseases, diabetes, and cancer. Using antioxidants as preventive and therapeutic agents is recommended. In this study, the effect of selenium ions as inorganic antioxidant compound along with low-level laser therapy on human breast cancer cell line MDA-MB-231 was investigated.

Methods: Breast cancer cell line MDA-MB-231 was exposed to irradiation with a red laser source (660 nm; power density: 30 mW cm^2) and another was kept in the dark for 90 seconds. After treatment with laser, the cells were treated with different concentrations of selenium (0-100 µg/mL) for overnight. The MTT assay was used to determine the cell viability. The morphology of cells was studied using inverted light microscopy. All experiments were repeated three times.

Results: The results showed that early treatment with low-level laser and then selenium ions reduced the survival and growth of cells. While with the early treatment with selenium and then low-level laser therapy maintained cell survival, and cell death was not observed.

Conclusion: This study showed that low-level laser therapy alone is not able to kill breast cancer cells but along with selenium ions, it reduced the cell viability. The morphological study of the cells using inverted light microscopy has confirmed the MTT results.

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ABSTRACT 51

Current Status for Laser-Assisted Orthodontics in the Application of Ceramic Brackets

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ABSTRACT

Background: Due to the increased number of adult patients in orthodontics and the use of ceramic brackets foe esthetics purposes, achieving sufficient bond between ceramic brackets to tooth or porcelain surface has become a challenge. The aim of this study is to investigate different outcomes of laser-application in order to maintain efficient results in current orthodontic treatments with ceramic brackets.

Methods: The study protocol was based on PRISMA statement for systematic review. Electronic and manual searches for literature since 2011 were conducted. PubMed and Medline databases were accessed. Data extraction and analysis were performed by two independent individuals. Among fifty-three studies, only twenty studies were included based on the inclusion criteria. Different types of lasers were applied for various uses in ceramic brackets such as bonding, debonding, rebonding and the elimination of remaining composite on tooth surface.

Results: Co2, Er:YAG and Nd:YAG are the most common lasers in using ceramic brackets in orthodontics. Rapid rebonding of ceramic bracket was shown by the application of laser on tooth/porcelain surface. It also decreases the intrapulpal damage and enamel damage compared with the conventional method of bracket debonding.

Conclusion: The use of laser is an effective method in different aspects of bonding procedures for ceramic brackets. However, the comparison between the two common types of laser for the mentioned procedure needs to be analyzed.

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ABSTRACT 52

Assessment of Optimal Parameters for Conditioning of Enamel of Primary Teeth Using an Er:YAG Laser

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ABSTRACT

Background: Pediatric laser dentistry is a promising field in modern minimally invasive dentistry. In addition to the use of a high technology, the psychological effect on the child represents an important benefit which may positively influence the acceptance of subsequent dental treatments. The aim of the present study was to determine the optimal parameters for the conditioning of enamel of primary teeth using an Er:YAG laser.

Methods: Forty primary molars of approximately the same size with a caries-free buccal side were included. These teeth were randomly assigned to the eight groups of 5 specimens each. A LightWalker Er:YAG laser with a wavelength of 2940 nm from FOTONA with the hand Piece H02-N was used for Laser treatment. After laser application, the quality of laser treatment was evaluated with a "Scanning Electron Microscope". The increase in temperature during the laser treatment was measured by an IR-Camera through a window in the pulp area.

Results: Best results with an acceptable enamel surface for further treatment were observed with the following parameters: 150 mJ, 15 Hz; 2.25 W. The treated surface was prepared homogeneously without cracks, craters or areas where enamel was melted. The specimen temperature was below 40°C.

Conclusion: Er:YAG laser seems to be a suitable option for conditioning of enamel of primary teeth. These results have to be confirmed by further investigations with a larger number of specimens.

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ABSTRACT 53

To Evaluate the Effectiveness of Diode Laser on Bleaching Color-Changed Teeth Under Laboratory Conditions

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ABSTRACT

Background: White teeth are an important measure of beauty, and today, the use of laser tooth bleaching is growing. The purpose of this study is to evaluate the effectiveness of diode lasers, on whitening teeth, discolored previously by tea, coffee, or pomegranate juice pigments.

Methods: In this experimental study, 72 healthy bovine incisors were selected, prepared, and divided into 3 groups of 24 numbers. They were placed in a solution of tea, coffee, or pomegranate juice, for 2 weeks. Each group was divided into 2 sub-groups of 12. The first sub-groups was bleached by a bleaching gel 35% and 940 nm diode laser. Laser was applied to each tooth, with four cycles of 30 seconds, and a power of 7 W. The second subgroups were bleached by 35% gel, for 16 minutes as controls. Next, the teeth stains were measured by spectrophotometry. Data were entered into the software SPSS version 20 and analyzed using descriptive statistics, *t* test, and ANOVA, with a significance level ($P<0.05$).

Results: After placement of tooth-colored materials (coffee, tea or pomegranate juice), three groups of pigments created significant color change ($P=0.000$ in each group), the component (l, a, b). The most discoloration was created in coffee and a mild change of color was detected in pomegranate juice. The effectiveness in whitening discolored-teeth, with and without laser diodes, showed no significant statistical difference ($P\geq0.05$). In the treatment groups, with and without laser, the highest effectiveness of bleaching (13.90 = ΔE with laser), (11.31 = ΔE without laser) was in the tea group, and least effective bleaching (6.51 = ΔE with laser), (5.85 = ΔE without laser) was obtained in the pomegranate juice group.

Conclusion: Regardless of the type of tooth discoloration, this study suggests that there is a relationship between the type of discoloration of the enamel and the efficacy of the bleaching treatment. 940 nm diode laser did not increase the effectiveness of catalytic bleaching.

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ABSTRACT 54

Evaluation of Er:YAG Laser Irradiation Effect on Microtensile Bond Strength in Different Steps of PANAVIA F2 Cement Application

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ABSTRACT

Background: Nowadays, the vast laser applications can be studied for dental science promotion, especially in the field of resin-systems adhesion improvement. Therefore, the aim of this study is the evaluation of Er:YAG laser irradiation effect on microtensile bond strength in different steps of PANAVIA F2 cement application.

Methods: In our study, 45 (n=15) healthy and non-carious molar teeth were randomly classified into 3 groups as below: 1) control, 2) Er:YAG + primer + Panavia F2 (Er-B-P), and 3) primer + Er:YAG + Panavia F2 (Er-A-P). In this procedure, Er:YAG laser (Fotona, Slovenia) was used with the following parameters: 2490 nm wavelength, frequency 10 Hz, power 0.4 W, energy density 40 mJ, short pulse, distance 5 mm and sweeping motion. Statistical analysis was performed by one-way ANOVA and Tukey tests in SPPS software (16th version).

Results: According to the results of post hoc Tukey, means of microtensile bond strength in Er-B-P (10.52) and Er-A-P (13.45) were significantly different ($P<0.05$). There was no statistically significant difference between the means of Er-B-P and Er-A-P with control (11.48) groups ($P>0.05$). This research found that, Er:YAG laser irradiation had no effect on microtensile bond strength. This might be due to high water absorption and minimum thermal effect of Er:YAG laser irradiation.

Conclusion: The results of our study showed that irradiation of Er:YAG laser with the mentioned characteristics in different steps of PANAVIA F2 cement application had no statistically significant effect on microtensile bond strength improvement.

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ABSTRACT 55

Regenerative Periodontal Treatment With an Er:YAG Laser 2940 nm

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ABSTRACT

Background: Periodontal diseases are among the most common oral diseases in adults. The desire for simple and effective treatment alternatives is thus understandable. Results with lasers in the 3-mikrometer-area (for example Er:YAG) are promising. Aim: Minimally invasive regenerative treatment of a periodontal defect by means of an Er:YAG Laser.

Methods: After periodontal charting, scaling and root planning were performed. At reevaluation, tooth 33 showed a periodontal probing depth of 10 mm on the distobuccal site. A laser intervention with the KEY3 (chisel tip, 160 mJ, 10 Hz) was performed.

Results: Periodontal probing depth was reduced to 3 mm and the x-ray after 18 months showed regeneration of the intrabony defect.

Conclusion: The case demonstrates that treatment of an intrabony defect with an erbium-laser could be a minimally invasive intervention for periodontal regeneration.

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ABSTRACT 56

Effect of Low-Level Laser Irradiation on Cellular Response of Human Skin Fibroblast Incubated With PAHs as Toxic Environmental Hazard Pollution

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ABSTRACT

Background: Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous environmental pollutants that have toxic effects on organisms through various actions. Routes of exposure to PAHs include ingestion, inhalation, and dermal contact. Benzene is the smallest member of the PAHs family which is widely used in different ranges of industries. Studies have shown that exposure to benzene leads serious health risks for humans. In this study, the effect of low-level laser was investigated on benzene-induced cytotoxicity in human skin fibroblast cells.

Methods: Human skin fibroblast cell line (Hu02) was exposed to various concentrations of benzene (0-100 µg/mL). After a further incubation of 2 hours, one plate was irradiated with a red laser source (660 nm; power density: 30 mW cm^2) and another was kept in the dark for 90 seconds. The MTT assay was used to determine the cell viability. The morphology of the cells was studied using inverted light microscopy. All experiments were repeated three times

Results: The effect of low-level laser therapy on the viability of the cells was positive at concentrations 0-15 µg/mL but negative at higher concentrations than 15 µg/mL.

Conclusion: Low-level laser therapy in low concentrations of benzene, decreases the cytotoxicity caused by benzene and maintains cell viability. At high concentrations of benzene, the cell viability decreases in comparison with dark experiment. The morphological study of the cells using inverted light microscopy has confirmed the MTT results.

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ABSTRACT 57

Scanning Electron Microscope Evaluation of Composite Surface Irradiated by Different Powers of Er:YAG Laser

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ABSTRACT

Background: The aim of this study was to evaluate the composite surface treated by different powers of Erbium-Doped Yttrium Aluminum Garnet (Er:YAG) laser in comparison with bur preparation via scanning electron microscope.

Methods: Fourteen composite resin blocks with 15× 10 × 10 mm dimensions were used in this study. The samples were divided into 7 groups as follows: Group 1 (power: 1 W, Energy: 50 mJ); Group 2 (power: 2 W, Energy: 100 mJ); Group 3 (power: 3W, Energy: 150 mJ); Group 4 (power: 4 W, Energy: 200 mJ); Group 5 (power: 5W, Energy: 250 mJ); Group 6 (power: 6 W, Energy: 300 mJ); Group 7: Diamond bur. Then, the samples were prepared for scanning electron microscope (SEM) examination.

Results: The surface treated with Er:YAG laser showed irregular and micro porous surface. "Surface treated by Er:YAG laser with a power of 1 W, 50 mJ (Original magnification x500, x2000)". "Surface treatment by bur (Original magnification x500, x2000)."

Conclusion: It seems that composite surface treatment by Er:YAG laser can be an alternative method for composite repair if suitable parameters are used.

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ABSTRACT 58

Review of Auto-fluorescent Effect on Diagnosis of Oral Malignant and Pre-malignant Lesions

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ABSTRACT

Background: Genetically altered cells could become widespread across the epithelium of patients with oral cancer, often, in clinically and histologically normal tissue and contribute to recurrent disease. Auto-fluorescence imaging has immerged as a promising technology to aid clinicians in screening for oral neoplasia and as an aid to resection. Tissue optics could further extend our understanding of alteration to phenotype as a result of molecular changes.

Methods: Fifteen papers were found in a research conducted in the PubMed search engine with keywords: fluorescent, oral, malignant and premalignant from 1996 to 2017.

Results: By using a handheld device in the operating room in patient with histologically confirmed neoplasia, fluorescent visualization (FV) decreased. In the most dysplastic lesions, FV loss extended in at least one direction beyond the clinically visible tumor. Molecular analysis on margins with low grade or no dysplasia showed a significant association of LOH (loss of heterozygosity) in FVL (fluorescent visualization loss) biopsies, with LOH at 3p and/ or 9p (previously associated with local tumor recurrence).

Conclusion: The data have shown that direct FV can identify subclinical high-risk fields with cancerous and precancerous changes in the operating room setting.

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ABSTRACT 59

In Vitro Evaluation of Pulpal Temperature Rise and Efficiency of Bleaching With Diode Laser and LED

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ABSTRACT

Background: Today, esthetics is a large part of dentistry. Many patients require beautiful smile, because the beauty and the supreme smile is very impressive in terms of social and personal situations. Bleaching is one of the most popular esthetic dental treatments in recent decades because it is easier, cheaper and more efficient than other treatments. To accelerate the bleaching process, we can use different methods such as light and temperature. In this study, the temperature rise in pulp, after using LED and diode laser, as auxiliary devices in the bleaching process are examined and also the effectiveness of these methods were compared.

Methods: In this present study, two types of bleaching gel (Xtra boost, Heydent) and two types of light sources (Diode laser, LED) were used in order to accelerate the bleaching process. Four groups consisting of 12 samples each were examined in this study. 48 bovine incisors were stained in a solution of tea for 21 days. The color of the samples before the bleaching was determined by the SpectroShade. Bleaching was done with materials in addition to different light sources as told before. Then the color of the samples was measured again with SpectroShade to evaluate the effectiveness of the different methods after the bleaching process and also pulpal temperature rise. Tukey test was used to compare the results between the groups.

Results: Data analysis showed that (LED+Xtra boost) had the lowest temperature rise and (Diode laser + Xtra boost) had the highest temperature rise in the pulp. It should be noted that temperature rise of (Diode laser + Heydent) was higher than (LED + Heydent) and less than (Diode laser + Xtra boost). The highest efficiency was achieved in (LED + Xtra boost) followed by (Diode laser + Xtra boost) and then by (LED+Heydent) and finally by (Diode laser + Heydent).

Conclusion: Statistical analysis showed a significant difference in temperature rise between the four groups ($P<0.05$), but bleaching efficiency was the same in them. LED is the better assistance for the bleaching process because it has the lowest temperature rise and high efficiency in dental bleaching process.

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ABSTRACT 60

Shear Bond Strength of Nanocomposites With 2 Dentin Bondings After Tooth Preparation With Bur and Er:YAG Laser

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ABSTRACT

Background: According to the increasing use of dental nano-composite resin in anterior and posterior restorations, increasing bond strength is considered an important aspect of restorations. The differences in structure and characteristics of dental bonding can affect their bond strength to dentin. Nowadays, laser because of many different advantages is considered as a promising technology. The goal of this study is the comparison of bond strength of different dentin bindings in teeth that are prepped with bur and laser.

Methods: Forty-eight intact third molars were collected, and after disinfection, put in acrylic mold. Then their enamel grinding was done to reach smooth dentin surface. The teeth were divided into 4 groups. Dentin preparation was done by bur in groups 1 and 2, using Single Bond Universal and Adper Single Bond 2 in these groups respectively. In groups 3 and 4, dentin was prepared by Er: YAG laser and the same 2 adhesives were applied according to manufacturer's instructions. Then bonding strength test was done after placement of nano dental composite to these dentin surfaces.

Results: Mean of bond strength in group 1 to 4 was respectively: 16.33 ± 4.53 MPa, 17.5 ±4.44 MPa, 10.42±1.97 MPa and 8.08 ± 2.74. In the laser groups, the bond strength was significantly lower than in the bur groups.

Conclusion: Laser in dentin preparation has an adverse effect on underlying dentin and reduces bond strength. Two dentin bondings didn't show different bond strength values.

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ABSTRACT 61

Evaluation of CO2 Laser Irradiation Assisted Titanium Tetrafluoride Gel Effect on Enamel Demineralization Around Orthodontic Brackets: An In Vitro Study

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ABSTRACT

Background: Demineralization of enamel around orthodontic brackets is a clinical problem which can lead to some challenges of esthetic concerns like white spot lesions. The aim of this in vitro study was to assess the caries-preventive potential of carbon dioxide (CO2) laser application in conjunction with the use of titanium tetra fluoride gel in inhibiting demineralization of enamel surrounding orthodontic brackets when exposed to cariogenic challenge.

Methods: Eighty healthy permanent human premolars were used. Metal orthodontic brackets were bonded to all the teeth. Then all the teeth were painted with 2 layers of acid-resistant nail varnish on all surfaces except the boxes area cervical to the brackets. They were randomly assigned into four groups (n=20): topical 4% TiF4 gel, CO2 laser (P: 0.25 W, E: 12.5 mJ, RR: 20 Hz, PD: 140 µs, 11% air, without water, for 10 s); fluoride + laser group (F + L), and control group (C). Then, the teeth were immersed in pH-cycling solutions for 10 days. The mean lesion depths were subsequently determined using polarized light microscopy. The data were analyzed by one-way analysis of variance (ANOVA) and Tukey post hoc test.

Results: Significant differences were found between group C and all other groups ($P<0.05$). There were significant differences between the mean lesion depth of the F+L and L groups in comparison to the F group ($P<0.05$). The results in the L and F+L groups were similar. The L+F group had the shallowest average lesion.

Conclusion: Considering the fact that this is an in vitro study, it can be suggested that treatment of enamel surface around brackets with CO2 laser and TiF4 could result in less enamel demineralization during the course of orthodontic treatment. Using TiF4 fluoride gel alone was not as effective as laser in preventing caries formation around brackets. Taking into cognizance the fact that the combination of CO2 laser and fluoride significantly decreased enamel mean lesion depth compared with fluoride treatment alone, this study suggests its use in preventing enamel demineralization around orthodontic brackets.

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ABSTRACT 62

Efficacy of Low-level Laser Therapy on Orofacial Pain: A Literature Review

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ABSTRACT

Background: Low-level laser therapy is a therapeutic approach to treat orofacial pain using a 600-1000 nm laser with less than 500 mW power. The efficacy of LLLT is due to the chemical reactions causing an anti-inflammatory and analgesic effect on the affected regions. The aim of this study is to review the effects of Low-level laser application on orofacial pain.

Methods: In the English articles released since 2010. Our search keywords were "low-level laser therapy, temporomandibular disorders, mucositis, orofacial pain" and the most relevant Clinical trial, review and meta-analysis articles, 26 out of 243 searched articles were selected from Electronic databases such as PubMed, Google Scholar and Science Direct and reviewed.

Results: Most of the investigators reported the positive role of low-level laser therapy on orofacial pain relief regardless of their variable procedures, however the exact mechanism of action still remains unclear. In TMD some studies indicated that LLLT significantly reduces pain, suffering myofascial pain, amount of clicking and both masseter and temporal muscles activity.

Conclusion: As an overall result, it is concluded that LLLT can serve as a therapeutic method for myofascial pain, mucositis, and temporomandibular joint disorders and this is due to its analgesic features.

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