



# iBrush Benefits

*Let There Be Light*

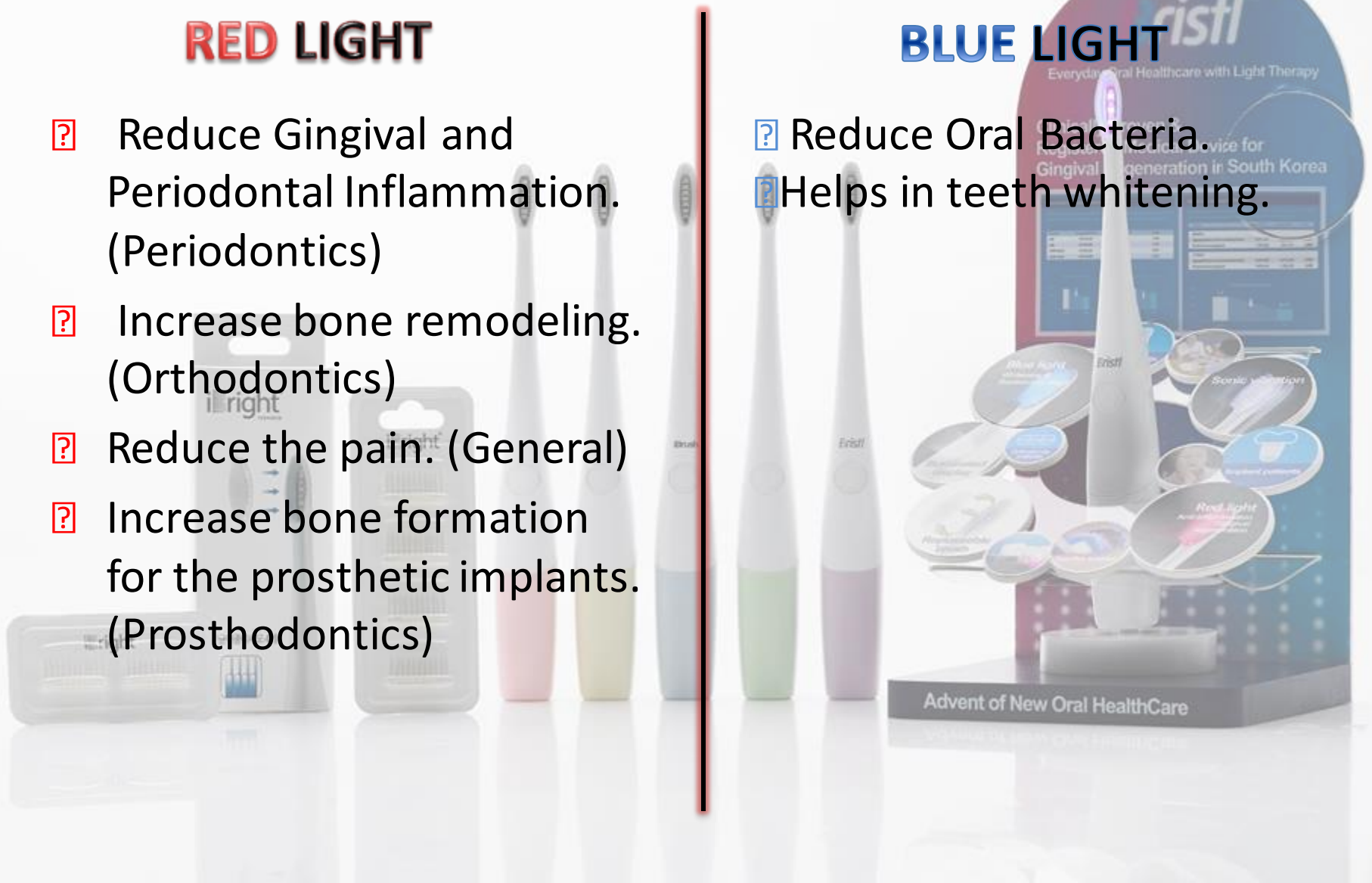
# iBrush Benefits For Patients

## RED LIGHT

- ❑ Reduce Gingival and Periodontal Inflammation. (Periodontics)
- ❑ Increase bone remodeling. (Orthodontics)
- ❑ Reduce the pain. (General)
- ❑ Increase bone formation for the prosthetic implants. (Prosthodontics)

## BLUE LIGHT

- ❑ Reduce Oral Bacteria.
- ❑ Helps in teeth whitening.



# iBrush Benefits For Dentists

## RED LIGHT

- ❑ Less inflammation for the patients specially in the follow up visits.
- ❑ Saving chair time through the reduction of the inflammation.
- ❑ Build more trust between the dentists and their patients.
- ❑ Faster teeth movements and bone remodeling.

## BLUE LIGHT *ristl™* Everyday Oral Healthcare with Light Therapy

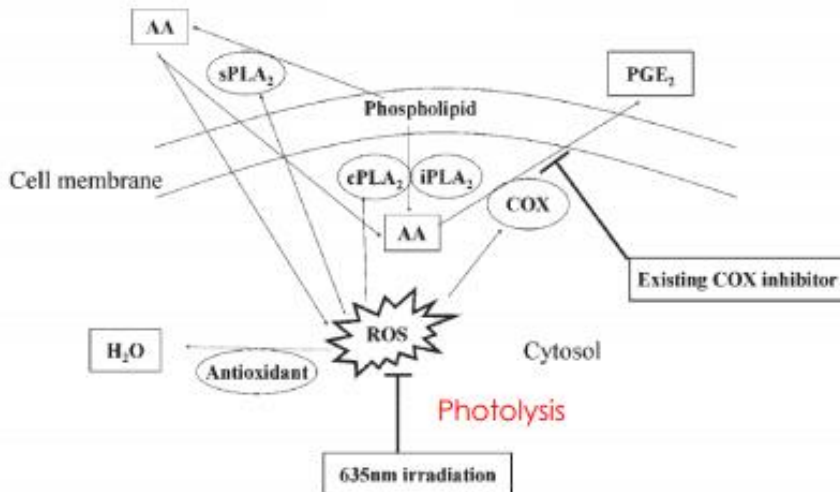
- ❑ Reduce Oral Bacteria. Therefore, better success rate for prosthetic Implants.
- ❑ Reducing bacterial infections.
- ❑ Helps in maintaining the teeth whitening specially after the whitening sessions.
- ❑ Detection of Dental Caries.

# iBrush Collection



# MECHANISM

## 1. ANTI-INFLAMMATORY EFFECT



635 nm irradiation

Reduces cellular ROS (Reactive Oxygen Species)

level and therefore suppresses expression of

COX2 (cyclooxygenase – an enzyme playing

Important role in inflammatory response)

which downregulates conversion of

Arachidonic Acid to Prostaglandin which causes

fever, pain, and bone loss.

# MECHANISM

## 2. ACCELERATED HEALING

635 nm irradiation activates transcription factors such as Jun/Fos and I $\kappa$ B/NF- $\kappa$ B (Inhibitor Kappa B/ Nuclear Factor Kappa B) to enter into the cell's nucleus and act to promote DNA transcription related to cell's growth and proliferation.

1) Mitochondria are involved in supplying cellular energy and other tasks such as signaling, cellular differentiation, and cell death, as well as maintaining control of the cell cycle and growth

2) AP-1 is a transcription factor that regulates gene expression in response to a variety of stimuli, including growth factors, and bacterial infections

3) NF- $\kappa$ B controls transcription of DNA and cell survival involved in cellular response to stimuli such as light and bacteria among others.

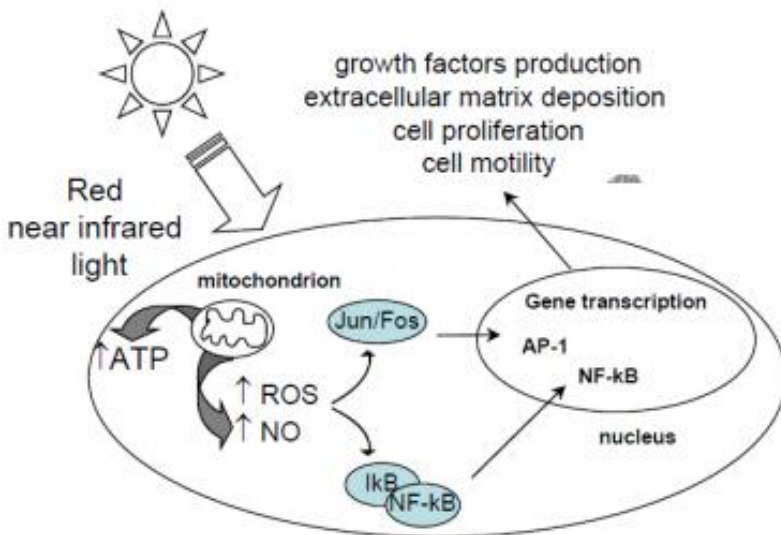


Figure 6. Cell signaling pathways induced by LLLT.

# MECHANISM

## ELECTRON TRANSPORT CHAIN IN CHLOROPLAST AND MITOCHONDRIA

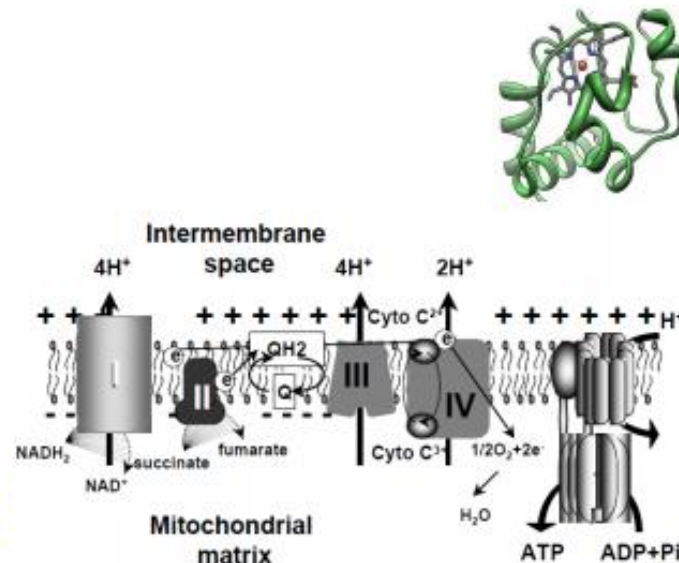
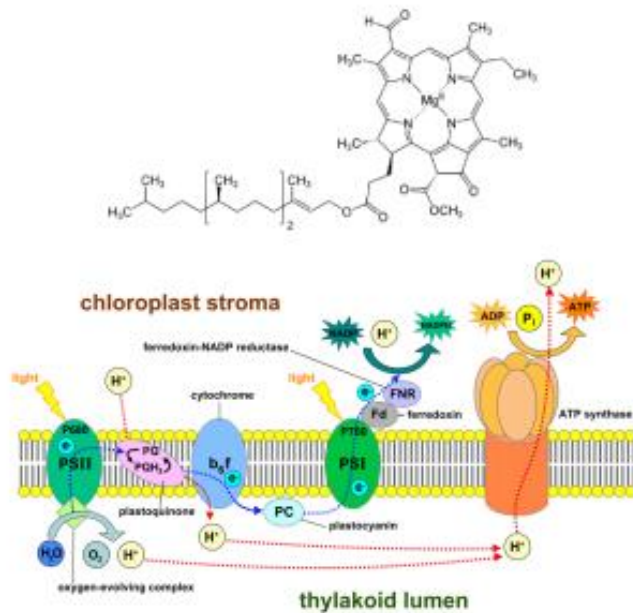


Figure 3. Structure of the mitochondrial respiratory chain

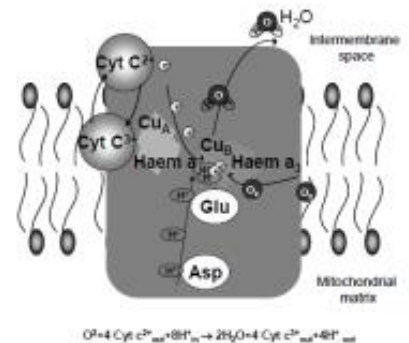


Figure 4. Structure and mode of action of cytochrome c oxidase

# MECHANISM

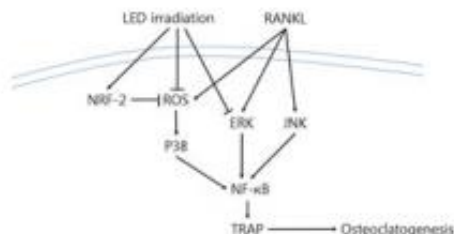
## 3. BONE GENERATION

Lasers Surg Med. 2015 Nov;47(9):745-55. doi: 10.1002/lsm.22413. Epub 2015 Sep 22. Effects of light-emitting diode irradiation on RANKL-induced osteoclastogenesis.

Bone homeostasis is maintained by a balance between osteoblastic bone formation and osteoclastic bone resorption

- low-level light therapy (LLLT), a form of laser medicine used in various clinical fields, was shown to alleviate oxidative stress by scavenging intracellular ROS. The present study aimed to investigate the impact of 635 nm irradiation from a light-emitting diode (LED) on osteoclastogenesis from receptor activator of nuclear factor kappa-B (NF- $\kappa$ B) ligand (RANKL)-stimulated mouse bone marrow-derived macrophages (BMMs).

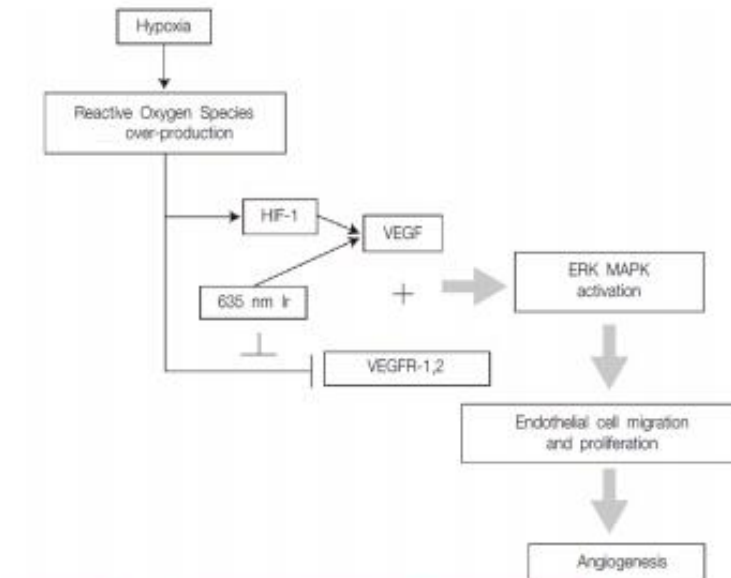
Figure 7: Diagrammatic representation of putative intracellular ROS generation and osteoclastogenesis pathways, along with possible points of 635 nm LED irradiation involvement. ROS generation and ERK phosphorylation in the RANKL-facilitated osteoclastogenesis model leads to p38 MAPK phosphorylation, NF- $\kappa$ B activation, TRAP expression and activation, and finally osteoclastogenesis. In the present study, LED irradiation attenuated the production of intracellular ROS and upregulation of NRF-2 expression, inhibition of ERK and P38 phosphorylation culminating in the suppression of TRAP expression/activation, and ultimately mitigating osteoclastogenesis.



1. ROS : Reactive Oxygen Species, mediates osteoclastogenesis
2. MAPK: mitogen activated protein kinase (=ERK, extracellular signal-regulated kinases)
3. P38 MAPK: critical for normal immune and inflammatory response, cell cycle, cytoskeleton remodeling
4. RANKL: Receptor activator of nuclear factor kappa-B ligand
5. NF- $\kappa$ B: DNA Transcription factor – cell survival
6. TRAP: Tartrate resistant acid phosphatase, expressed by osteoclasts and degrades skeletal phosphoproteins.
7. Osteoclastogenesis: generation of osteoclast (bone destroying cell)

# MECHANISM

## ANGIONENESIS

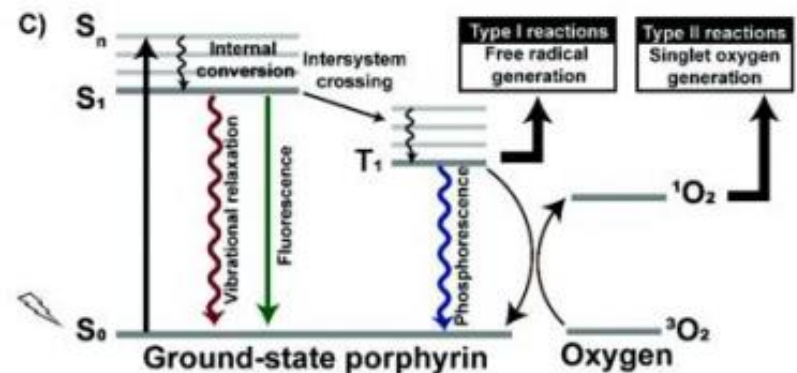
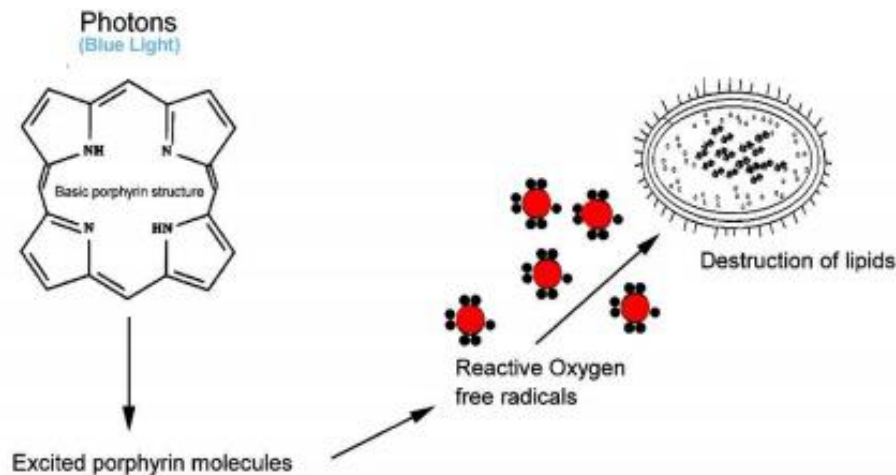


HIF-1: Hypoxia inducible factors  
- TXN factors responding to dec in oxygen, hypoxia  
VEGF: Vascular endothelial growth factor  
VEGFR: Vascular endothelial growth factor receptor

VEGFR suppression by ROS and  
angiogenesis by 635 nm

# MECHANISM

## HOW BLUE LIGHT KILLS PORPHYROMONAS GINGIVALIS



Mechanism of *P. gingivalis* destruction by visible light interaction with porphyrins. When exposed to absorbed light wavelengths, porphyrins act as photosensitizers and generate highly reactive free radical species, one of which is singlet oxygen. These radicals are potent oxidizers and destroy the lipids in the cell wall.

# MECHANISM

## HOW BLUE LIGHT ENHANCES TOOTH WHITENING

Mechanism : Blue light activates Titanium dioxide (whitening pigment of toothpaste) and accelerates photocatalytic effect on  $\text{TiO}_2$  surface and therefore enhances the break-down reaction of hydrogen peroxide releasing bleaching factors faster.

### Clinical evidence

Treatment effects of photodynamic therapy for whitening power through electric toothbrush with single frequency light emitting diode, 2015, Dankook University school of dentistry

### Conclusion :

1. Whitening effect shown upto 4 shades (vita shade) in 8 weeks in canine teeth.
2. Based on the results, it is suggested that the continuous use of LED toothbrush with whitening toothpaste has whitening effect and protect against staining for a long period.

# MECHANISM

## VISUAL IDENTIFICATION OF DENTAL CARIES



Evidences on antimicrobial effect

| CLAIM                | Evidence  | Nature of Study  | Source   |
|----------------------|---|--|--|
| Antimicrobial effect | Fusobacterium spp. were reduced in the laser group  | Microbiologic results after non-surgical erbiumdoped:yttrium, aluminum, and garnet laser or air-abrasive treatment of peri-implantitis: a randomized clinical trial          | Persson et al. (2011) J Periodontol. Sep;82(9):1267-78. doi: 10.1902/jop.2011.100660. Epub 2011 Mar 21.        |
| Antimicrobial effect | It was concluded that the adjunctive use of aPDT in combination with SRP showed the best therapeutic results in the treatment of periodontal disease in rats.                           | Adjunctive effect of antimicrobial photodynamic therapy in induced periodontal disease. Animal study with histomorphometrical, immunohistochemical, and cytokine evaluation. | De Oliveira et al. (2016) Lasers Med Sci. Sep;31(7):1275-83. doi: 10.1007/s10103-016-1960-5. Epub 2016 Jun 28. |
| Antimicrobial effect | PDT and SRP suppressed Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola stronger, and resulted in fewer persisting pockets after 6 months, than DSL application. | Treatment of residual pockets with photodynamic therapy, diode laser, or deep scaling. A randomized, split-mouth controlled clinical trial                                   | Cappuyns et al. (2012) Lasers in Medical Science. 27:979. doi: 10.1007/s10103-011-1027-6.                      |

| CLAIM                | Evidence   | Nature of Study   | Source   |
|----------------------|--|---|--|
| Antimicrobial effect | Photodynamic therapy could be an effective supplement in root canal disinfection. PDT using LED lamp (630 nm) was more effective than diode laser 810 nm in reducing CFUs of E. faecalis in human teeth. | A comparison of the antibacterial activity of the two methods of photodynamic therapy (using diode laser 810 nm and LED lamp 640 nm) against Enterococcus faecalis in extracted human anterior teeth. | Asnaashari et al. (2016) Photodiagnosis Photodyn Ther. 2016 Mar; 13:233-7.   |
| Antimicrobial effect | LLLT had an inhibitory effect on the microorganisms, and this capacity can be altered according to the interactions between different microbial species.   | In viro effect of low-level laser therapy on typical oral microbial biofilms.   | Basso et al. (2011) Baz Dent J. 2011;22(6):502-10.   |
| Antimicrobial effect | We expect more to see applications of PDT to more challenging infections using advanced antimicrobial photosensitizers targeted to microbial cells in the years to come                                  | Photodynamic therapy for infections: clinical applications  | Kharkwal et al. (2011) Sep;43(7): 75-67. doi: 10.1002/lsm.21080. Wellman Center for Photomedicine, Massachusetts General Hospital, Boston, MA, USA |

| CLAIM                                       | Evidence   | Nature of Study  | Source   |
|---|--|--|--|
| Antimicrobial effect & gum health promotion | This study demonstrated that the photodynamic therapy using photosensitizer and a 662 nm laser light source is distinctly advantageous in reducing the periodontal signs of redness and bleeding on probing. The procedures also appears to significantly suppress P. gingivalis | Efficacy of photodynamic therapy on inflammatory signs and two selected periodontopathogenic species in a beagle dog model                         | Sigusch et al. (2005) Jul; 76(7):1100-5. Journal of Periodontology. Clinic for conservative dentistry, An der alten Pist 4, 07740 Jena, Germany. (1) |
| Antimicrobial effect                        | Exposure to blue LED delayed the growth of P. gingivalis, while red LED did not. The blue LED irradiation did lead to a remarkably decreased expression of genes associated with chromosomal DNA replication and cell division after 5 minutes; exposure to the red LED did not. | Blue LED inhibits the growth of Porphyromonas gingivalis by suppressing the expression of genes associated with DNA replication and cell division. | Chanthoeun et al. (2012) Lasers Surg Med. Dec;44(10):856-64. doi: 10.1002/lsm.22090. Epub 2012 Nov 5.  |
| Antimicrobial effect                        | Within the limits of the present study, it can be concluded that SRP combined with photodisinfection leads to significant improvements of the  | Treatment of periodontal disease by photodisinfection compared to scaling and root planing   | Online Research Laboratories, Inc., (2007) J clin Dent. 2007; 18(2):34-8   |

| CLAIM                | Evidence   | Nature of Study   | Source   |
|----------------------|--|---|--|
| Antimicrobial effect | In the field of dentistry, many studies have shown that photodynamic therapy can destroy periodontopathogenic bacteria in a biofilm  | Short-term clinical effects of adjunctive antimicrobial photodynamic therapy in periodontal treatment: a randomized clinical trial. | Braun et al. (2008) Journal of Clinical Periodontology; 35: 877-84.                        |
| Antimicrobial effect | Growth of bacteria irradiated at 400 nm and 410 nm was significantly suppressed compared with a non irradiated control, whereas wavelength of 430 nm and longer produced no significant inhibition. A constant energy density of 15J/C,2 was found to be enough to show an inhibitory effects. Significant inhibition of bacteria growth was found after only 1 min at 50 mW/Cm2 irradiation | Specific-wavelength visible light irradiation inhibits bacterial growth of Porphyromonas gingivalis                                 | Yoshioka et al. (2008) Journal of Periodontal Research. 2008 Apr;43(2):174-8. doi: 10.1111 |

| CLAIM                | Evidence  | Nature of Study  | Source  |
|----------------------|---|--|---|
| Antimicrobial effect | Blue light alone significantly reduced bacterial and FG viability. Combined with ERY, it significantly reduced PD viability. Blue light is lethal to bacteria and filamentous fungi although effectiveness is dependent on light purity, energy levels and microbial genus. | Blue light (470 nm) effectively inhibits bacterial and fungal growth   | De Lucca et al. (2012) Lett Appl Microbiol. Blue light (470 nm) effectively inhibits bacterial and fungal growth. |
| Antimicrobial effect | LLLT had an inhibitory effect on the microorganisms, and this capacity can be altered according to the interactions between different microbial species.  | In vitro effect of low-level laser therapy on typical oral microbial biofilms.   | Basso et al. (2011) Braz Dent J. 2011;22(6):502-10  |
| Antimicrobial effect | Within the limits of this study, BL was found to have an antimicrobial/growth-inhibiting effect on P. gingivalis, and a-PDT using a combination of BL and RB shows promise as a new technical modality for bacterial elimination in periodontal therapy.                    | Antimicrobial effect of photodynamic therapy using high-power blue light emitting diode and red-dye agent on Porphyromonas gingivalis. | Hiratsuka et al. (2013); 48:696-705 Journal of periodontal research   |

# Evidences on gum health improvement

| CLAIM                | Evidence  | Nature of Study  | Source   |
|----------------------|---|--|--|
| Improves gum health  | PPD was significantly decreased in the SRP+PT group (P=0.00). Further, PPD and CAL showed significantly greater changes in the SRP+PT group than in the SRP group (PPD, P=0.03; CAL, P=0.04)  | The effects of adjunctive daily phototherapy on chronic periodontitis  | Jung et al. (2014), J Periodontal Implant Sci. Dec;44(6):280-7. doi: 10.5051/jpis.2014.44.6.280. Epub 2014 Dec 31. |
| Reduces inflammation | Results showed that 635 nm irradiation and existing COX inhibitors inhibit expression of COX and PGE(2) release. Unlike indomethacin and ibuprofen, 635 nm irradiation leads to a decrease of ROS levels and mRNA expression of cytosolic phospholipase A(2) (cPLA(2)) and secretory phospholipase A(2) (sPLA(2)) | The Anti-inflammatory Mechanism of 635 nm Light Emitting Diode Irradiation Compared with Existing COX inhibitors | Choi et al. (2007), Lasers in Surgery and Medicine 39:614-621.   |
| Reduces inflammation | This suggests that 635 nm LED irradiation might be useful not only in reducing inflammation but also in diminishing osteoclast genesis. Furthermore, 635 nm LED irradiation might be a useful treatment modality for patients with diabetic periodontitis.  | Effects of 635 nm irradiation on high glucose-boosted inflammatory responses in LPS-induced MC3T-E1 cells        | Choi et al. (2012), Lasers Med Sci DOI 10.1007/s10103-012-1122-3   |

| CLAIM                    | Evidence   | Nature of Study   | Source   |
|--------------------------|--|---|--|
| Improves gum health      | These observations suggest that both wavelength and cell type influence the cell proliferation response to low-intensity laser irradiation.  | Effect of wavelength on low-intensity laser irradiation-stimulated cell proliferation in vitro                          | Ridgway et al. (2005) Lasers Surg Med. University of Oklahoma College Dentistry, Oklahoma City, Oklahoma 73104, USA(1) |
| Reduces inflammation     | Visible red LED irradiation appears to active the skin-homing immune system  | Light-Emitting Diode Phototherapy at 630 +/- 3 nm Increases Local Levels of Skin-Homing T-cell in Human Subjects.       | Takezaki et. al. Journal of Nippon Medical School, 206 April: 73(2): 75-81.  |
| Reduces inflammation     | In the aPDT-treated groups, the periapical region was moderately/severely enlarged with no inflammatory cells, moderate neoangiogenesis and fibrogenesis, and the smallest periapical lesions  | Antimicrobial photodynamic therapy for the treatment of teeth with apical periodontitis: a histopathological evaluation | Silva et al. (2012) Journal of Endodontics. Mar;38(3): 360-6. doi: 10.1016/j.joen.2011.12.023                          |
| Anti-inflammatory effect | LED light (660 nm) with an energy density of 10 J/cm2 appeared suitable as an adjunct modality for periodontitis by temporarily reducing inflammation, facilitating collagen realignment and bundle bone deposition. Future studies will aim to amplify the biostimulatory effect of LED light by adding a supplementary medium or repeated irradiation. | Irradiation by light-emitting diode light as an adjunct to facilitate healing of experimental periodontitis in vivo.    | Chang et al. (2013) J Periodontal Res. 2013 Apr;48(2): 135-43. doi: 10.1111/j.1600-0765.2012.01511.                    |

| CLAIM                    | Evidence   | Nature of Study  | Source  |
|--------------------------|--|--|---|
| Anti-inflammatory effect | LED light (660 nm) with an energy density of 10 J/cm2 appeared suitable as an adjunct modality for periodontitis by temporarily reducing inflammation, facilitating collagen realignment and bundle bone deposition. Future studies will aim to amplify the biostimulatory effect of LED light by adding a supplementary medium or repeated irradiation. | Irradiation by light-emitting diode light as an adjunct to facilitate healing of experimental periodontitis in vivo. | Chang et al. (2013) J Periodontal Res. 2013 Apr;48(2): 135-43. doi: 10.1111/j.1600-0765.2012.01511. |

| CLAIM                           | Evidence  | Nature of Study  | Source  |
|---------------------------------|---|--|---|
| Improves gum health             | Red light therapy is shown to speed up healing of wounds and reduce inflammation in the gums.   | Periodontal and peri-implant wound healing following laser therapy   | Aoki et al. (2015) Periodontol 2000. 2015 Jun;68(1):217-69. doi: 10.1111/prd.12080.   |
| Reduces inflammation            | The potential benefits of LLLT that have been demonstrated in many healthcare fields and include improved healing, reduced inflammation and pain control, which suggest considerable potential for its use in oral tissues. | Developments in the low-level light therapy (LLLT) for dentistry   | Carroll et. al (2014) Dent Mater. 2014 May;30(5):465-75. doi: 10.1016/j.dental.2014.02.006. Epub 2014 Mar 21.                                 |
| Reduces pain (hypersensitivity) | Results demonstrate that the low level laser therapy is an effective method for the treatment of both thermal and tactile dentinal hypersensitivity.  | Low level laser therapy for dentinal tooth hypersensitivity  | Gerschman et al. (1994) Aust Dent J. Oro-Facial Pain Clinic, Faculty of Medicine, Dentistry and Health Sciences, University of Melbourne (1). |
| Reduces inflammation            | Antimicrobial photodynamic therapy acts as a beneficial adjunct to SRP in non-surgical treatment and management of chronic periodontitis in short-term.   | Efficacy of antimicrobial photodynamic therapy in the management of chronic periodontitis: a randomized controlled clinical trial. | Betsy et al. (2014) Journal of Clinical Periodontology. Department of Periodontics, Government Dental College, Thiruvananthapuram, India.     |

| CLAIM    | Evidence   | Nature of Study   | Source  |
|----------|--|---|---|
| Collagen | <p>Within the limitations of this experimental study (sample size and arbitrary energy densities), the results indicated that LLLT (Nd:YAG 1064 laser) did not cause cell death for the settings used. It appears that these settings of Nd:YAG laser are safe. Moreover, the cell proliferation of primary cultured gingival fibroblasts increased after laser irradiation, presenting a potentially dose-dependent action. LLLT (Nd:YAG, 1064 laser) contributes probably to the secretion of EGF in a reverse dose-response pattern. Finally, it becomes clear that more studies with larger sample sizes are needed, in order to draw solid conclusions. Future studies should consider evaluating growth factors, irradiation parameters, and/or laser wavelengths.</p> | <p>Effect of Nd:YAG Low Level Laser Therapy on Human Gingival Fibroblasts</p> | <p>Andreas et al. (2015) Int J Dent. 2015; 2015: 258941. Department of Periodontology, School of Dentistry, University of Athens, 2 Thivon Street, Goudi, 115 27 Athens, Greece</p> |

| CLAIM                           | Evidence   | Nature of Study  | Source   |
|---------------------------------|--|--|--|
| Reduces pain (hypersensitivity) | The VAS analysis revealed a significant decrease in dentin hypersensitivity in 7 days with the use of the desensitizer and low-level laser therapy and no statistically significant difference was observed between these two treatments. Low-level laser therapy and desensitizer application had displayed similar effectiveness in reducing moderate dentin hypersensitivity. | Low-level laser therapy of dentin hypersensitivity: a short-term clinical trial.   | Aksoy et al. (2011) Laswers Med Sci. Sept;26(5): 591-8. doi: 10.1007/s10103-010-0794-9. Department of Oral Diagnosis and Radiology, Faculty of Dentistry, University of Ankara, Ankara, Turkey(1). |
| Oral ulcer                      | Complete resolution of the ulcers in the active group was 3.05 +/- 1.10 days as compared to 8.90 +/- 2.45 days in the sham control group. Immediately post the LLLT application, complete pain relief was observed in 28 of the 30 patients of the active group.   | Efficacy of low-level laser therapy in treatment of recurrent aphthous ulcers- A sham controlled, split mouth follow up study. | J Clin Diagn Res. 2014 Feb; 8(2): 218-221  |

| CLAIM                | Evidence   | Nature of Study   | Source   |
|----------------------|--|---|--|
| Reduces inflammation | The use of low level light therapy or photobiomodulation has demonstrated its efficacy in these studies.   | Photobiomodulation and implants: implications for dentistry               | Arny et al. (2013), J Periodontal Implant Sci 2013;43:262-268/   |
| Collagen secretion   | This study assessed the impact of various light delivery modes on collagen production in human primary fibroblast cultured in monolayers after three treatments with red light-emitting diode illumination (630 nm, 8 J/cm(2)). Results demonstrated that, 72 h post-baseline, specific microsecond pulsing patterns had a more favorable impact on the ability of fibroblasts to produce collagen de novo than comparative conditions of continuous wave, pulsed 50% duty cycle, and millisecond pulsing domains. | Importance of pulsing illumination parameters in low-level-light therapy. | Barolet, D., Duplay, P., Jacomy, H. & Auclair, M. Importance of pulsing illumination parameters in low-level-light therapy. J. Biomed. Opt 15, 048005–048005–8 (2010). |

| CLAIM                                   | Evidence   | Nature of Study   | Source  |
|---|--|---|---|
| Reduces inflammation (peri-implantitis) | The use of LLLT at the range of doses between 1.5 and 3 J/cm2 may modulate the activity of cells interacting with an implant, thereby enhancing tissue healing and ultimate implant success.           | The effect of low level laser irradiation on implant-tissue interaction. In vivo and in vibro studies | Khadra M et al. (2005) Swed Dent J Suppl. (172):1-63                                  |
| Reduces inflammation (peri-implantitis) | These results support the hypothesis that peri-implant defects can be treated successfully by laser decontamination without damaging the surrounding tissues in the dog model                          | Peri-implant care of ailing implants with the carbon dioxide laser                                    | Deppe et al. (2001) Int J Oral Maxillofac Implants Sept-Oct16(5):659-67               |
| Reduces inflammation                    | Patients treated with the LED device demonstrated significantly improved dental implant stability.   | Accelerated implant stability after LED photobiomodulation  | Brawn et al. (2008), J Dent Res 87 (Spec Iss B):2021, 2008                            |
| Reduces inflammation (peri-implantitis) | With increasing evidence of benefits, therapies with low-and high-level laswers play an important role in wound healing/tissue regeneration in the treatment of periodontal and peri-implant diseases. | Periodontal and peri-implant wound healing following laser therapy                                    | Aoki et al. (2015), Periodontol 200. 2015 Jun; 68(1): 217-69. doi: 10.1111/prd.12080. |

| CLAIM                | Evidence   | Nature of Study   | Source  |
|----------------------|--|---|---|
| Reduces inflammation | COX-2 protein expression and PGE(2) production were significantly increased in the LPS-treated group and decreased by LED irradiation. LPS treatment of gingival fibroblasts led to the increased release of the pro-inflammatory-related cytokines interleukin-6 (IL-6) and IL-8, whereas LED irradiation inhibited their release. Analysis of MAPK signal transduction revealed a considerable decrease in p38 phosphorylation in response to 635-nm radiation either in the presence or absence of LPS. In addition, 635-nm LED irradiation significantly promoted JNK phosphorylation in the presence of LPS. LED irradiation can inhibit activation of pro-inflammatory cytokines, mediate the MAPK signaling pathway, and may be clinically useful as an anti-inflammatory | Inflammatory cytokines are suppressed by light-emitting diode irradiation of P. gingivalis LPS-treated human gingival fibroblasts: inflammatory cytokine changes by LED irradiation | Choi et al. (2012), Lasers Med Sci DOI 10.1007/s10103-011-0971-5            |
| Collagen synthesis   | Healthy human fibroblasts showed better cell proliferation and collagen synthesis when they were irradiated at wavelength of 635 nm+830 nm or 830 nm.  | Effect of Low-Level Laser Therapy on Proliferation and Collagen Synthesis of Human Fibroblasts in Vitro   | Ma et al. (2018) Journal of Wound Management and Research 2018; 14(1): 1-6. |

| CLAIM                | Evidence  | Nature of Study   | Source  |
|----------------------|---|---|---|
| Reduces inflammation | LLLT can offer tremendous therapeutic benefits to patients, such as accelerated wound healing and pain relief.  | Low Level Laser Therapy in Dentistry  | Goyal et al. (2013), Int J Laser Dent 2013; 3(3):82-88                            |
| Reduces inflammation | Based on the conditions employed in the present study, LPT (Laser phototherapy) is capable of accelerating the oral mucosa wound-healing process. Moreover, faster and more organized reepithelization and tissue healing of the oral mucosa were achieved with an energy density of 4J/Cm <sup>2</sup> | Influence of different energy densities of laser phototherapy on oral wound healing                             | Wagner et al. (2013), Journal of Biomedical Optics 18(12), 128002                 |
| Reduces inflammation | Inflammation Low level laser therapy was an effective treatment with no side effects and it may be considered as an alternative therapy for erosive/ulcerative oral lichen planus.  | Use of low level laser therapy for oral lichen planus: report of two cases                                      | Mahdavi et al. J Dent (Shiraz) 2013 Dec; 14(4): 201-204.                          |
| Reduces inflammation | PDT may serve as an adjunctive therapy to SRP treatment in periodontal pockets with PD ≥5 mm to reduce the presence of bleeding in these lesions.   | Adjunctive effect of photodynamic therapy to scaling and root planing in the treatment of chronic periodontitis | Ge et al. (2011) Photomed Laser Surg. Jan;29(1):33-7, doi: 10.1089/pho.2009.2727. |

| CLAIM                | Evidence   | Nature of Study   | Source   |
|----------------------|--|---|--|
| Reduces inflammation | The results showed that, under hypoxic/ischemic conditions, irradiation with 635 leads to reduced production and increased scavenging of intracellular ROS, which results in alleviation of VEGFR-1 suppression, enhanced VEGF expression and ERK MAPK activation, and subsequent acceleration of angiogenesis with improved cell viability and tube formation | The Effects of 635 nm Light emitting diode irradiation in peri-implantitis in vitro model | Choi et al. (2012), Kor J Oral Maxillofac Pathol 2012;36(4):219-230.<br>Choi et al. (2012), Kor J Oral Maxillofac Pathol 2012;36(4):219-230. |

| CLAIM   | Evidence   | Nature of Study   | Source  |
|---------|--|---|---|
| Healing | LED produced in vitro increases of cell growth of 140-200% in mouse-derived fibroblasts, rat-derived osteoblasts, and rat-derived skeletal muscle cells, and increase in growth of 155-171% of normal human epithelial cells. Wound size decreased up to 36% in conjunction with HBO in ischemic rat models. LED produced improvement of greater than 40% in musculoskeletal training injuries in Navy Seal members, and decreased wound healing time in crew members aboard a U.S. Naval submarine. LED produced a 47% reduction in pain of children suffering from oral mucositis. | Effect of NASA Light-Emitting Diode Irradiation on Wound Healing. | Whelan et. al. Journal of Clinical Laser Medicine & Surgery. 2001 December: 305-14. |

| CLAIM       | Evidence   | Nature of Study   | Source   |
|-------------|--|---|--|
| Pain relief | Phototherapy demonstrated a significant reduction in patient-reported pain as measured by the WHO criteria in this patient population included in this study. Improvement trends were noted in most other assessment measurements.   | Amelioration of Oral Mucositis Pain by NASA Near-Infrared Light- Emitting Diodes in Bone Marrow Transplant Patients | Hodgson et.al. Supportive Care in Cancer, 2012 July: 1405-15.  |
| Healing     | Fibroblasts proliferated faster than endothelial cells in response to laser irradiation. Maximum cell proliferation occurred with 665 and 675 nm light, whereas 810 nm light was inhibitory to fibroblasts.  | Effect of Wavelength on Low-Intensity Laser Irradiation-Stimulated Cell Proliferation In Vitro.                     | Pete Moore, MS, DDS, Tisha D. Ridgway, MS, Russell G. Higbee, DVM, PhD, Eric W. Howard, PhD, and Michael D. Lucroy, DVM, MS, DACVIM. Lasers Surg. Med. 36: 8-12, 2005. |
| Healing     | Biologists have found that cells exposed to near-infrared light from LEDs, which is energy just outside the visible range, grow 150 to 200 percent faster than cells not stimulated by such light. The light arrays increase energy inside cells that speed up the healing process | Amelioration of oral mucositis pain by NASA near-infrared light-emitting diodes in bone marrow transplant patients  | Hodgson et al. Support Care Cancer. 2012 Jul;20(7): 1405-15. doi: 10.1007/s00520-011-1223-8.   |
| Healing     | 1.4 mw helium-neon (670 nm) diode laser for 30 seconds (fluence = 0.34 J/cm2). Healing rates were evaluated clinically and photographically. Sixty-nine percent of the irradiated incisions healed faster than the control incisions.  | Rapid healing of gingival incisions by the helium-neon diode laser.   | Neiburger, E.J. Rapid Healing of Gingival Incisions by the Helium-Neon Diode Laser. Journal of the Massachusetts Dental Society. 199 Spring: 8-13, 40.                 |

| CLAIM   | Evidence  | Nature of Study   | Source   |
|---------|---|---|--|
| Healing | Treatment with laser biostimulation showed a beneficial effect on wound healing in diabetic rats. It can be concluded that low-level laser therapy (808 nm laser at 10 J/cm(2)) can have a beneficial effect on diabetic wound healing, when used at 2 d intervals over 5 d.  | Effect of biostimulation on wound healing in diabetic rats.   | Gungormus et al. (2009) Photomed Laser Surg. 2009 Aug; 27(4): 607-10. doi: 10.1089/pho/2008.2349         |
| Healing | LLLT elicits a positive healing effect on palatal mucoperiosteal wounds, and modulates the oxidative status in experimental diabetic rats.  | The effects of low-level laser therapy on palatal mucoperiosteal wound healing and oxidative stress status in experimental diabetic rats. | Firat et al. (2013) Photomed Laser Surg. Jul;31(7):315-21. doi: 10.1089/pho.2012.3406. Epub 2013 Jun 21. |
| Healing | Scalpel incisions heal more slowly than diode and diode + biostimulation incisions in diabetic rats. We can suggest that diode + biostimulation may produce the least amount of tissue injury, with the fastest resolution of inflammatory response in diabetic rats. Diode laser incision (4 W) with 10-J/cm(2) LLLT seems to have a beneficial effect on skin incisions in diabetic rats. | The effect of low-level laser therapy on healing of skin incisions made using a diode laser in diabetic rats.                             | Akyol et al. (2010) Photomed Laser Surg. 2010 Feb;28(1):51-5. doi: 10.1089/pho.2008.2425.                |

| CLAIM   | Evidence   | Nature of Study   | Source  |
|---------|--|---|---|
| Healing | Substantia spongiosa formation was slightly more evident in Groups 1 and 3 than in Group 2. Also, there was more union in Group 3 than in the other groups on day 20. As a result, it can be concluded that low-level laser therapy (808 nm laser at 10 J/cm <sup>2</sup> ) can have a beneficial effect on spongiosa in diabetic bone repair when five treatments are administered with 2 d intervals between | Effect of Biostimulation on Healing of Bone Defects in Diabetic Rats                            | Akyol et al. (2010) Photomedicine and Laser Surgery, Vol. 28, No.3  |
| Healing | According to the results of the present study, low-power laser irradiation can affect the enzymatic antioxidant system of salivary glands of streptozotocin-induced diabetic rats.   | Laser irradiation affects enzymatic antioxidant system of streptozotocin-induced diabetic rats. | Ibuki et al. Lasers Med Sci. 2013 May;28(3):911-8. doi: 10.1007/s10103-012-1173-5. Epub 2012 Aug 7.           |
| Healing | This study suggests that superpulsed laser irradiation may be a treatment of choice for patients scheduled for tooth extraction, as it provides clinical efficacy, is safe and well tolerated, and is able to prevent inflammation.  | Influence of superpulsed laser therapy on healing processes following tooth extraction.         | Mozzati et al (2011) Photomed Laser Surg. 2011 Aug;29(8):565-71. doi: 10.1089/pho.2010.2921. Epub 2011 Jun 1. |

| CLAIM   | Evidence  | Nature of Study   | Source   |
|---------|---|---|--|
| Healing | LLLT significantly decreased the rate of OTM into the bone-grafted surgical defects by accelerating defect healing and maturation, particularly when the start of postoperative OTM was delayed.  | Effect of low-level laser therapy on orthodontic tooth movement into bone-grafted alveolar defects.   | Kim et al. (2015) Am J Orthod Dentofacial Orthop. 2015 Oct;148(4):608-17. doi: 10.1016/j.ajodo.2015.04.034.          |
| Healing | LED light could an adjunct to promote early PDGF-aided dentoalveolar osteogenesis by facilitating the osteoblast-osteoclast coupling.   | Combination of LED light and platelet-derived growth factor to accelerate dentoalveolar osteogenesis.   | Chang et al. (2014) J Clin Periodontol. Oct;41(10):999-1006. doi: 10.1111/jcpe.12301. Epub 2014 Sep 15.              |
| Healing | aser irradiation for 5 min caused the highest expressions of genes and proteins related to bone healing. In conclusion, LLLT had positive effects on the early stages of bone healing of extraction sockets in rats, which were irradiation time-dependent. | Effects of increased low-level diode laser irradiation time on extraction socket healing in rats.   | Park et al (2015) Lasers Med Sci. Feb;30(2):719-26. doi: 10.1007/s10103-013-1402-6. Epub 2013 Aug 9.                 |
| Healing | We suggest that this lower-level laser therapy protocol can improve tissue response and accelerate the recovery of neurosensory disorders following BSSO.   | Lower-level laser therapy improves neurosensory disorders resulting from bilateral mandibular sagittal split osteotomy: a randomized crossover clinical trial | Gasparini et al. (2014) J Craniomaxillofac Surg. Jul;42(5):e130-3. doi: 10.1016/j.jcms.2013.07.009. Epub 2013 Sep 4. |

| CLAIM                    | Evidence  | Nature of Study   | Source  |
|--------------------------|---|---|---|
| Healing osseointegration | <p>Within the limits of this study, photofunctionalization expedited and enhanced osseointegration of commercial dental implants in various clinically challenging/compromised bone conditions.</p> <p>Photofunctionalization resulted in preservation--and often a gain--of marginal bone level, and long-term large-scale clinical validation is warranted.</p> | Photofunctionalized dental implants: a case series in compromised bone.                         | Funato et al. (2013) Int J Oral Maxillofac Implants. Nov-Dec;28(6):1589-601. doi: 10.11607/jomi.3232. |
| Healing                  | The significantly lower incidence of alveolar osteitis after antimicrobial photodynamic therapy seems to be a new and promising possibility for the prevention of alveolar osteitis.  | Antimicrobial photodynamic therapy for prevention of alveolar osteitis and post-extraction pain | Neugebauer et al. (2004) Mund Kiefer Gesichtschir. 2004 Nov;8(6):350-5. Epub 2004 Sep 29.             |

| CLAIM   | Evidence   | Nature of Study  | Source   |
|---------|--|--|--|
| Healing | <p>LLLT can promote bone healing and bone mineralization and thus may be clinically beneficial in promoting bone formation in skeletal defects. It may be also used as additional treatment for accelerating implant healing in bone. LLLT can modulate the primary steps in cellular attachment and growth on titanium surfaces. Multiple doses of LLLT can improve LLLT efficacy, accelerate the initial attachment and alter the behaviour of human gingival fibroblasts cultured on titanium surfaces. The use of LLLT at the range of doses between 1.5 and 3 J/cm<sup>2</sup> may modulate the activity of cells interacting with an implant, thereby enhancing tissue healing and ultimate implant success.</p> | <p>The effect of low level laser irradiation on implant-tissue interaction. In vivo and in vitro studies</p> | <p>Khadra et al. (2005) Swed Dent J Suppl. 2005;(172):1-63</p> |

| CLAIM                | Evidence   | Nature of Study   | Source   |
|----------------------|--|---|--|
| Healing              | These results support the hypothesis that peri-implant defects can be treated successfully by laser decontamination without damaging the surrounding tissues in the dog model. Nevertheless, further investigations will be required to determine the clinical efficacy of the treatment.                  | Peri-implant care of ailing implants with the carbon dioxide laser.                             | Deppe et al. (2001) Int J Oral Maxillofac Implants. 2001 Sep-Oct;16(5):659-67.                               |
| Orthodontic movement | We demonstrated that LPT positively affected an important aspect of dental movement; the hyalinization. In the present study, we found a significant reduced expression of hyalinization after 19 days. On irradiated subjects, hyalinization was increased at day 7 with significant reduction at day 13. | Effect of laser phototherapy on the hyalinization following orthodontic tooth movement in rats. | Habib et al. (2012) Photomed Laser Surg. 2012 Mar;30(3):179-85. doi: 10.1089/pho.2011.3085. Epub 2012 Feb 9. |
| Orthodontic movement | A statistically significant increase in the movement speed of irradiated canines was observed in comparison with nonirradiated canines in all evaluation periods. No statistically significant difference was observed in bone and root resorption of canines, whether irradiated or not.                  | Influence of low-level laser on the speed of orthodontic movement.                              | Sousa et al. (2011) Photomed Laser Surg. 2011 Mar;29(3):191-6. doi: 10.1089/pho.2009.2652. Epub 2011 Jan 23. |

| CLAIM                | Evidence  | Nature of Study   | Source   |
|----------------------|---|---|--|
| Healing              | These findings suggest that low-energy laser irradiation facilitates the velocity of tooth movement and MMP-9, cathepsin K, and integrin subunits of alpha(v)beta3 expression in rats.  | Low-energy laser irradiation facilitates the velocity of tooth movement and the expressions of matrix metalloproteinase-9, cathepsin K, and alpha(v)beta(3) integrin in rats. | Yamaguchi et al. (2010) Eur J Orthod. 2010 Apr;32(2):131-9. doi: 10.1093/ejo/cjp078. Epub 2010 Feb 16.           |
| Orthodontic movement | The laser of low power promotes the expression of bFGF in the periodontal tissue and alveolar bone remodeling.  | A study on expression of basic fibroblast growth factors in periodontal tissue following orthodontic tooth movement associated with low power laser irradiation               | Zhu et al. (2002) Hua Xi Kou Qiang Yi Xue Za Zhi. 2002 Jun;20(3):166-8.  |
| Hyposalivation       | The results of this study showed that the LLLT increased unstimulated salivary flow rate significantly. However, stimulated salivary flow rate did not increase significantly after the LLLT. In patients who underwent sham laser therapy, neither unstimulated nor stimulated salivary flow rate increased significantly. | The Effectiveness of Low-Level Laser Therapy in Patients with Drug-Induced Hyposalivation: A Pilot Study.   | Terlevic et al. (2016) Photomed Laser Surg. 2016 Sep;34(9):389-93. doi: 10.1089/pho.2016.4109. Epub 2016 Jul 14. |

Claims associated  
whitening teeth

| CLAIM         | Evidence  | Nature of Study   | Source   |
|---------------|---|---|--|
| Whitens teeth | Color and temperature changes were significantly affected by an interaction of the bleach and light variables. The application of lights significantly improved the whitening efficacy of some bleach materials, but it caused significant temperature increases in the outer and inner tooth surfaces. The IR and CO2 laser lights caused the highest tooth temperature increases. | Effect of light energy on peroxide tooth bleaching.   | Luk K, Tam L, Hubert M. Effect of light energy on peroxide tooth bleaching. J Am Dent Assoc. 2004; (135): 194-201  |
| Whitens teeth | Within the limitations of this study, the treatment with supplementary light showed significantly greater bleaching-dependent changes in color compared to treatment without light when assessed using instrumental methods.  | Color change of vital teeth exposed to bleaching performed with and without supplementary light | Ontiveros JC, Paravina RD. Color change of vital teeth exposed to bleaching performed with and without supplementary light. J Dent. 2009 Nov;(37): 840-847 |

| CLAIM         | Evidence  | Nature of Study  | Source   |
|---------------|---|--|--|
| Whitens teeth | Peroxide and light treatment significantly lightened the color of teeth to a greater extent than did peroxide or light alone, with a low and transient incidence of tooth sensitivity. Light can increase the tooth-whitening effect of peroxide, thereby increasing the effectiveness of tooth-whitening procedures.   | Light augments teeth whitening with peroxide                           | Tavares et al. J Am Dent Asso. 2003 Feb; 134(2): 167-75  |
| Whitens teeth | At the termination of the study, the statistical analysis of the Vita Shade scores indicated that both products significantly ( $p < 0.0001$ ) lightened the color of the teeth. The average improvement was between 6 and 9 shade changes. Additionally, the Zoom! Chairside System was significantly better than the Opalescence Xtra Boost Kit at all time points: post-treatment ( $p < 0.0001$ ); Day 2 ( $p < 0.004$ ); Day 7 ( $p < 0.003$ ). This difference was between 1 and 2 shade changes. | Clinical study to compare two in-office (chairside) whitening systems. | Gallagher et al. Clinical study to compare two in-office (chairside) whitening systems. J Clin Dent. 2002; 13(6):219-224 |

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