The Effectiveness of Polarized Light in Musculoskeletal, Skin Problems and Burns

Nicolaou Valentina¹, Stasinopoulos Dimitrios²* and Lamnisos Dimitrios³

¹Physical therapist MSc in Sports Physiotherapy, European University, Cyprus
²Department of Physiotherapy, Faculty of Health and Caring Sciences, University of West Attica, Greece
³Department of Health Sciences, School of Sciences, European University Cyprus

*Corresponding author: Stasinopoulos Dimitrios, Department of Physiotherapy, Faculty of Health and Caring Sciences, University of West Attica, Greece

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Abstract

Introduction: The purpose of this systematic review is to demonstrate through studies that have investigated the therapeutic power of polarized light in musculoskeletal, skin problems and burns. We will see through reviews how each question is answered individually and what problem gives the best therapeutic results. Bioptron Light is a patented non-invasive optical device and technology based on the biostimulatory effects of polarized and inconsistent light in the visible and infrared spectrum.

Method: After a comprehensive strategic search, articles were searched through computerized databases Health and medical complete Pro Quest, Ebsco, Google Scholar in the years 2002-2019 and in English only. The effects of polarized light on musculoskeletal, skin, and burns were compared and evaluated, which yields exactly as well as lagging behind as research evidence. A total of nineteen randomized clinical trial studies were collected, two of which were pilot studies in English only. The effects of polarized light were compared and evaluated in eleven studies of polarized light therapy in musculoskeletal, five in dermatological and ulcer treatment, and in three in treatment of pregnancy. Individuals, children, women, and men were included in the studies. The methodological quality of these studies was assessed using the 12 quality assessment criteria of each randomized controlled study by Furlan et al. [1] and the composite best evidence by Van Tulder et al. [2].

Results: Only 19 randomized, high-quality, randomized studies were collected from the search.

Conclusions: Studies of high methodological quality appear to respond positively to the purpose and investigation of this review. They always support the efficacy of polarized light to overcome musculoskeletal problems, but it is also important for its action on skin problems and burns.

Keywords: Polarized light; Muscles; Skin problems; Burns

Introduction

Existing knowledge (bibliography review)

The effect of polarized light on the musculoskeletal system: A review of the literature has

found that studies investigating the relationship between polarized light in skeletal, skin and burns are poor in terms of treatment as monotherapy but how it can be used as monotherapy and / or as adjunctive therapy to treat pain. In the following indications: Rheumatology (osteoarthritis, rheumatoid arthritis, chronic arthritis), Physiotherapy (low back pain, shoulder and neck pain, carpal tunnel syndrome, scar tissue, muscle [3].

Generally known from studies in the literature to date on this topic, refer to a pilot study by Stasinopoulos in 2015, how the use of polarized multicolored non-cohesive light is a respectable treatment in musculoskeletal in Acute epicondylitis in the elbow, but nevertheless refers to this study how while Bioptron light is a reliable, safe and effective treatment option in pregnant patients, it is necessary to perform controlled clinical trials in order to determine the absolute and relative effective HLA this intervention. In his study, Stasinopoulos and his colleagues in 2008 reported that polarized light had effects on elbow tendonitis and ankle sprains.
In a 2014 study by Seyed and colleagues, however, Bioptron’s application of different treatment protocols and light parameters different from those used in this study, perhaps longer duration of treatment and long-term evaluation may reveal different results in favor of treatment with Bioptron. But in the 2016 study of michos, he argued that more research is needed to determine whether polarized light is a powerful tool for treating tendonitis in general [4].

Interesting is the study of Song in 2015, which reported that the combination of type A allantoxin infusion with ultrasound and infrared polarized light showed a significant clinical effect on migraine treatment [5].

It is supported in a study on how phototherapy including low-level lasers as a cohesive light source and polarized UV-free multicolored without coherent light is recommended as a non-aggressive, safe and cost-effective treatment option for the treatment of various musculoskeletal disorders and skin conditions.

It is argued that Bioptron® phototherapy can be beneficial for people of all ages, including children and infants. Bioptron® Light phototherapy can be used in children as a complementary treatment to reduce pain and promote healing in various types of conditions, such as: Skin disorders, upper airway infections (common cold, vaginal infections) and tonsils, tonsils bones [3].

Bioptron® phototherapy can be used as monotherapy and / or as adjunctive therapy for pain treatment in the following indications: Rheumatology (osteoarthritis, rheumatoid arthritis, chronic arthritis), Physiotherapy (low back pain, shoulder and neck pain, neck and neck pain, syndrome) scar tissue, muscle. In the 2019 Svenda study, you report how the tribal fracture as one of the most common fragments of the population that mainly affects women and often leads to a complex peripheral pain syndrome. He concludes that Bioptron light therapy combined with conventional therapy improves the patient’s outcome after fracture in gerontology, compared to conventional therapy alone [6].

The search for new therapeutic approaches for back pain requires a need for physiotherapy practice. The polarized light emitted by the Bioptron device causes the skin to heat up because it contains infrared light. This exogenous light is interpreted as irritation by thermo-receptors and leads to activation of reflex and local reactions, improves microcirculation and nutrition of exposed tissues and has anti-inflammatory action. Light changes the sensitivity of the skin, increases tactile sensitivity and reduces sensitivity to pain. These results are confirmed by Ballyzek and his colleagues, who studied the change in the amount of unidentified pain in the neck and lower back when treated with low light energy. They believe that changing the sensitivity of receptors, hydrolyzing exchange products, reducing muscle tone and increasing tissue elasticity play a role in relieving pain.

The effect of polarized light on skin and burns: Clinical research has shown that BIOPTRON has a positive stimulating effect on specific skin cells known as fibroblasts, resulting in the production of collagen and elastin. Safe and non-invasive treatment with BIOPTRON FOR ONLY TEN minutes a day reduces wrinkles, without side effects. A 2015 study by Mageed reported that the effects of polarized light as adjuvant therapy for deep second-degree deep burns were not satisfactory and statistically insignificant. But it showed little improvement in the wound healing process. Therefore, it is considered necessary to conduct a critical research literature review in order to summarize the findings that will refer to the relationship between bioptron therapy in skeletal, skin and burns [7].

However, a 2018 study by Nesrein showed that purple filtered light polarized light has a special and beneficial effect on reducing scarring in children after burning.

Problem description

There is a need to conduct a systematic review of the research literature on this topic due to the poor bibliographic study of bioptron therapy in skeletal, skin and burns, which is exactly the superior treatment. The gaps in the literature and the lack of guidelines, the summary of existing scientific knowledge and the identification of contradictions or gaps in the literature and the lack of guidelines were serious reasons for this study [8-24].

Purpose and individual goals

The purpose of this critical bibliographic review is to analyze the prospective studies examining the relationship between polarized light therapy in skin skeletons and burns.

Methodology

Search strategy description

a) The present work is a systematic review study. In this systematic review, the databases used in this particular systematic review are related to the search in the relevant international bibliographies and the electronic databases Medline, Google Scholar, Pub med.

b) The key words and their combination are: polarized light, muscles, skin problems, burns.

The bibliography was also searched through the literature of other articles and reviews related to the subject under investigation.

Methodological Quality

For the evaluation of the methodological quality of each randomized study, the 12 criteria of Furlan et al. [2] were used, in an independent and methodological way. Each item was rated as “yes”, “no”, or “I don’t know/we’re not sure/there is ambiguity”.

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“High quality” studies were defined with the most positive yes answers and with a score of > 50%.

**Data Synthesis**

Composition of data the quantitative analysis of studies will be measured whether or not it is possible due to the heterogeneity of the measures of the results. Therefore, the results will be summarized using a better compound proof of results according to van Tulder et al. [1].

**Results**

At this stage, the results of the research studies that were reviewed are presented

**Study Flow Diagram**

Presentation and interpretation of the results of a study flow diagram which meet the criteria [Figure 1].

![Figure 1: Diagrammatic representation of the flow of systematic search results](image)

Score of methodological quality of the studies under review. Score SCOR of the methodological quality of the studies under review [25-30].

**The Evaluation of the methodological quality of the studies**

Outcome measures reported in eleven studies with musculoskeletal pain include pain assessment using a VAS analog scale and muscle paraesthesia as well as Caldwell-Sierra electrophysiological testing in a dynamometer with a dynamometer and its body in studies of syndromes. Complex peripheral pain syndrome (Sudeck Atrophy) after fracture. In a study on migraine research, a MIDAS disability assessment questionnaire and a quality of life scale were used. And Roland-Morris quality of life test in a patient with back pain.

The results will be summarized using a better compound proof of results according to Van Tulder et al. [1]. Expect the healing power of polarized light in musculoskeletal problems, skin problems and burns. We will see through reviews how each question is answered separately but also to which problem it gives the best therapeutic results.

Ten were of high methodological quality Van Tulder et al. [1] to describe the reduction of musculoskeletal pain in periarthritis and epicondylitis in the tribal fractures in the elderly, the quality of life-enhancing acupuncture by reducing back pain and improving mobility by using polarized light, in leather the three showed high methodological quality in its leather applications [8,9]. Only one showed a high methodological quality in reducing bed
sores, a moderate methodological study showed that nocturnal pain and paraesthesia associated with idiopathic carpal tunnel syndrome improved during polarization. Incoherent light [10-13]. In Durović’s [9] study, after a four-week polarized light treatment, 20 patients with stage I-III ulcer had a significant improvement in wound healing, so it could be useful to apply polarized light to their treatment, pressure ulcers. While in the study of Deen [14] report how More effective treatment of polarization in accelerating the healing of diabetic foot grade II ulcer from diode laser treatment [31-39].

Description of Studies Van Tulder et al. [1] Table 1, The polarized light in the musculoskeletal system.

**Table 1**: The polarized light in the musculoskeletal system.

| Subscribers | Subjects | Treatment Method | Output Measures | Intervention Parameters | Efficiency | SKOR |
|-------------|----------|------------------|-----------------|-------------------------|------------|------|
| Stasinopoulos [16]. | Pregnant women n = 46 | Bioptron light in the carpal tunnel in pregnant women from January 2006 to January 2010. | Pain and paraesthesia | Bioptron light 2 times a day for 5 days a week. 90w 480-3400nm 40mw 2.4j / cm² For 2 weeks | Improving finger strength and reducing pain | 75% |
| Svenda et al. [6] | Women n: 52 Group A n1: 26 B n2 group: 26 Complex peripheral pain syndrome (Sudeck Atrophy) | A = cryotherapy B = cryotherapy and bioptron | VAS and range of motion | A = anti-inflammatory exercises 30 minutes ball compression cryotherapy B = anti-inflammatory exercises cryotherapy and Bioptron for a total of 10 minutes a day in five places | Bioptron photon therapy in combination with conventional therapy improves patient outcome after DRF in gerontology, compared to conventional therapy only | 61% |
| Stasinopoulos et al. [16] | N=50 A=27 B=23 18-35 years | B = cryotherapy A = cryotherapy + bioptron | Vas analog scale, swelling and range of motion. | Cryotherapy with patches for 20min on the ankle every 2 hours for 5 days and the second group + bioptron for 10 minutes once a day for 5 days. | No significant difference was observed between the two groups at the end of treatment. | 92% |
| | N = 44 | A = splint and bioptron light | Vas scale pain | 10 sessions of Bioptron treatment 3 times a week for 8 minutes wavelength: 480-3400 nm accompanied by 8 weeks splint in the Bioptron group. The wrist splint in a neutral position was applied for 8 weeks to the control group. | Improvement of both teams but | 84% |
| Seyed et al. [15] | With carpal tunnel syndrom | B = splint | Caldwell-Sierra electrophysiological test | | No significant difference was observed between the two groups at the end of treatment. |
Huang et al. [5]  
N = 52 patients with either periarticular in the shoulder or chronic musculoskeletal pain syndrome or lateral epicondylitis  
A = group I were treated with NB or LB plus LPNIR. B = group I underwent treatment with NB or LB.  
Visual analog scales (VAS) were measured in all patients 6 months before treatment for the pain clinic between August 2007 and January 2008.  
Group I was treated with NB or LB plus LPNIR. Patients in group II, in turn, were treated with her procedures in group I, but without using LPNIR.

Stasinopoulos [12]  
Group A (n / 25) was treated with Cyriax physiotherapy. B = supervised exercise program C = polar multicolored non-cohesive light (Bioptron light).  
1. Two researchers they participated  
2. specialized dermatologist  
VAS and functionality with grip strength  
There were no significant differences between the groups in terms of pain. Cyriax and exercise and polarized multicolor incoherent light reduces pain and improved function at the end of treatment, in between and long term.
| Study | Participants | Intervention | Outcomes |
|-------|--------------|--------------|----------|
| Stasinopoulos et al. [16] | N = 50 | Group A exercise with LLLT program or an exercise program with polarized multicolored incoherent light. The exercise program consist of eccentric and static stretching exercises of the relaxed wrists. In the LLLT group a Ga-As 904 nm. In the team receiving polarized multicolored incoherent light used Bioptron 2 to administer the dose vertically the lateral epicondyle at three points at a working distance of 5-10 cm for 6 minutes in each position. | There were no significant differences in pain relief and improvement in function between groups at the end of treatment and follow-up for 3 months there was a decrease in pain and an increase in the function of both groups compared to the initial value (p < 0.0005) | 67% |
| Song et al. [5] | N = 91 patients with chronic migraine | Infrared polarized light in treatment chronic migraine combination of allantoxin type A | MIDAS Immigrant Disability Assessment Questionnaire MIDAS Score and Quality of Life Scale | Ο συνδυασμός αλλαντίασης-και-υπονοούμενου-οδηγούμενου τύπου Α αλλαντίασης η θεραπεία της χρόνιας ημικρανίας κατέδειξε σημαντική κλινική επίδραση. | 75% |
| Study                          | N          | Description                                                                 | Pain Assessment                                                                 | Pain Reduction                                                                 |
|-------------------------------|------------|------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Aragona et al. [19]           | N = 30     | Patients were first exposed to Bioptron® light for 20 minutes after the lesion had cleared | Pain: (assessed on the Vas scale) | Pain reduction was felt in 21 patients in 1 month (70%) and in 100% of cases in 3 months |
|                               | 19 women   |                                                                               | 24 sessions; twice a week for 12 weeks.                                           | 42%                                                                           |
|                               | 11 men     |                                                                               |                                                                                  |                                                                                |
| Stasinopoulos et al. [10]     | N = 25     | Polarized multicoloured inconsistent light (Bioptron light) was given vertically in the area of the carpal tunnel | Total participants’ estimates for nocturnal pain and hallucinations, respectively, at 4 weeks and 6 months | Nocturnal pain and paraesthesia associated with idiopathic carpal tunnel syndrome improved during polarized multicoloured inconsistent light (Bioptron light) |
|                               | patients   |                                                                               |                                                                                  | 50%                                                                           |
|                               | (22 women  |                                                                               |                                                                                  |                                                                                |
|                               | and three  |                                                                               |                                                                                  |                                                                                |
|                               | men)       |                                                                               |                                                                                  |                                                                                |
| Mihaylova et al. 2017         | N = 30     | Group A = basic treatment                                                      | A group = basic treatment                                                        | Both methods reduced pain, improved lumbar mobility and improved the quality of life of patients with lower back pain. |
|                               | 33 men and | Group B = basic treatment and bioptron                                         | Group B = basic treatment once a day as follows:                                |                                                                                  |
|                               | 27 women,  |                                                                               | ’LFMF with characteristics 16 000 A/m.1 Hz, 0.2 seconds, 15-20 minutes.         |                                                                                  |
|                               | ages 18-55 |                                                                               | ’Ultrasound treatment of the lumbar spine from L1 to S1 with a parameter of 0.4W/cm, 5 minutes on each side. ’Light treatment by Bioptron device for 10 minutes. + 10 minutes. Fragments in lumbar region |                                                                                  |

Result through the measures of exit of the van tulder scale 2003. This study concludes how through Powerful Indicators of Efficacy in Musculoskeletal Effects where studies excel at yielding polarized light with consistent positive (significant) findings in ten of the eleven studies analyzed within multiple high-quality randomized trials. With exit measures the Vas scale for musculoskeletal pain.

Main findings of clinical review studies predominate in musculoskeletal studies mainly through studies and mainly in Stasinopoulos’ study, 2017 the use of bioptron as monotherapy without control group in pregnant women, however, although it showed a significant reduction in pain and paraesthesia through analogous scale pain randomized controlled trials with virtual therapies should be performed. This as an attempt to conceive the long-term benefits of bioptron therapy compared to other therapies [16].

Also, the effectiveness of bioptron in the management of epicondylitis has been evaluated and in the pilot study of Stasinopoulos in 2005 it showed how treatment with Bioptron for 4 weeks led to a significant functional improvement and improvement of pain in patients with epicondylitis. However, the Stasinopoulos et al study in 2017 showed strong evidence for the effectiveness of Bioptron light therapy as an adjunct to cryotherapy in acute ankle sprains that offers significant pain and swelling reduction, but mention how stronger studies are required to confirm these results.

In Stasinopoulos’ 2005 study, nocturnal pain and paraesthesia associated with idiopathic carpal tunnel syndrome improved
during polarized multicolored non-coherent light through the Vas scale (Bioptron light) but still required controlled clinical trials.

**Discussion**

The therapeutic use of polarized light has deservedly gained its place in literature through various studies as a promising treatment equal to that of lasers [17]. However, Stasinopoulou’s [17] study provides preliminary evidence for the effectiveness of cryotherapy-supplemented Bioptron phototherapy for the treatment of ankle sprains. However, more studies are needed to confirm these results [40-43].

Even in Seyed’s 2014 study, treatment with Bioptron in patients with carpal tunnel syndrome showed exactly the same results as the group that wore only the splint, justifying the fact by stating that perhaps longer-term treatment with bioptron was superior in results. We found that light therapy significantly accelerated pain relief and improved, compared to conventional therapy where svenda’s study. Study by Medenica [18], showed that it significantly reduced the diameter of a wound from an ulcer, but its exact mechanism of action is still unknown, although there are even reports that it may be superior to the healing effect of laser therapy.

**Conclusions**

It is important for our science to clarify and explain how today is no longer the time for monotherapy applications, especially in regenerative medicine, and the adoption of biophysical therapies can play a positive anti-inflammatory and regenerative role, enhancing the function of non-invasive treatments [19].

Direction for future research, practice, results dissemination, education, health policy, clinical directions: In order for studies to be considered valid and effective in the treatment of bioptron polarized light in musculoskeletal, skin and burns, the studies should be numerous in number, randomized control tests and so that the results are compared with each other in various problems of musculoskeletal pain, functional pain, skin problems and burns.

**References**

1. Furlan AD, Pennick V, Bombardier C, Van Tulder M (2008) Updated method guidelines for systematic reviews in the Cochrane collaboration Back review group. Spine (Phila Pa 1976) 28(12): 1290-1299.
2. Van Tulder M, Furlan A, Bombardier C, Router L (2003) Updated method guidelines for systematic reviews in the Cochrane collaboration back review group. Spine (Phila Pa 1976) 28(12): 1290-1299.
3. Rifai (2016) Bioptron? Light therapy: polarized, incoherent, polychromatic and low energy light. Positive Health (167): 1-1.
4. Michos Ioannis, Talas Michalis, Lannisos Dimitrios, Dimopoulos Christos, Stasinopoulos Dimitrios (2016) Tendinopathy: The Role Polarised Polychromatic Non-Coherent Light Commonly called Bioptron Light. Journal of Prevention & Infection Control 2(11).
5. Song JH, Zhang GB, Ding XD, Huang L, Hong Y, et al. (2015) Efficacy of type a botulinum toxin injections and infrared polarized light on treating chronic migraine. Eur Rev Med Pharmacol Sci 19(11): 1976-1982.
6. Svenda zlakovic, Leitner C, Lazovic B, Petrovic DM (2019) Complex Regional Pain Syndrome (Sudeck Atrophy) Prevention Possibility and Accelerated Recovery in Patients with Distal Radius at the Typical Site Fracture Using Polarized, Polychromatic Light Therapy. Photobiomodul Photomed Laser Surg 37(4): 233-239.
7. Mageed Samir M Abdel, Ali Osman Selim, Mohamed A Abdel Ghafer, Rania Refaat Ali (2015) A Description of the Effect of Polarized Light as an Adjuvant Therapy on Wound Healing Process in Pediatrics. International Journal of Biophysics 5(1): 18-23.
8. Taly Arun B, Krishan P Sivanaran Nair, Thylothy Murali, Archana John (2004) Efficacy of Multim wavelength Light Therapy in the Treatment of Pressure Ulcers in Subjects With Disorders of the Spinal Cord: A Randomized Double-Blind Controlled Trial. Arch Phys Med Rehabil 85(10): 1657-1661.
9. Duvočić A, Marić D, Brcadarezi Ž, Jevtic M, Duđević S (2008) The effects of polarized light therapy in pressure ulcer healing. Vojnosanit Pregl 65(12): 906-912.
10. Stasinopoulos D (2005) The Use of Polarized Polychromatic Non-coherent Light as Therapy for Acute Tennis Elbow/ Lateral Epicondylalgia: A Pilot Study. Photomed Laser Surg 23(1): 66-69.
11. Huang D, Gu YH, Liao Q, Yan XB, Zhu SH, Gao QQ (2012) 00567496. 12. Stasinopoulos D, Stasinopoulou I (2006) Comparison of effects of Cryiixx physiotherapy, a supervised exercise programme and polarized polychromatic non-coherent light (Bioptron light) for the treatment of lateral epicondylitis. Clin Rehabil 20(1): 12-23.
13. Nesrein A Abd Elrashid, Doaa A Sanad, Noha F Mahmoud, Hamada A Hamada, Alhaima M Abdulmoety, et al. (2018) Effect of orange polarized light on post burn pediatric scar: a single blind randomized clinical trial. J Phys Ther Sci 30(10): 1227-1231.
14. Deen Heba balhey sheem fahmy, El sayed (2014) Polarized Light Versus Light-Emitting Diode on Healing of Chronic Diabetic Foot Ulcer. ROMANIAN J BIOPHYS 24(2).
15. Seyed Ahmad Raessadat, Seyed Mansoor Rayegani, Sajad Rezaei, Leyla Sedighpour, Mohammad Hasam Bahrami, et al. (2014) The Effect of Polarized Polychromatic Noncoherent Light (Bioptron) Therapy on Patients with Carpal Tunnel Syndrome. J Lasers Med Sci 5(1): 39-46.
16. Stasinopoulos Dimitrios, Ioannis Stasinopoulou (2017) Treatment of Carpal Tunnel Syndrome in pregnancy with Polarized Polychromatic Non-coherent Light (Bioptron Light): A Preliminary, Prospective, Open Clinical Trial. Laser Ther 26(4): 289-295.
17. Tondiy LD, Tondiy OL, Tondiy IV Kas, OV Zembyana, OL Zakrevska, VO Zhuravliev (2015) POLARIZED Light In Physiotherapy. Kharkiv Medical Academy of Postgraduate Education, “Clinical Sanatorium «Roscha» Pr.-A.C. Ukroppoz dorovnyts. ISSN 1996-1960. Медична інформатика та інженерія. No 4 .
18. Medenica L, Lens M (2003) The Use of Polarised Polychromatic Non-Coherent Light Alone as a Therapy for Venous Leg Ulceration. J Wound Care 12(1): 37-40.
19. Aragona SE, Grassi FR, Nardi G, Lotti J, Merighetti G, et al.(2017) Photobiomodulation with polarized light in the treatment of cutaneous and mucosal ulcerative lesions. J Biol Regul Homeost Agents 31: 213-218.
20. Ahmed Mamdouh Mohamed Abd Al-Kader, Maha A Hassan Halim Galal Mahran E kayed, Zakaria Mouraf Emam Mourafy (2015) Efficacy of Polarized Light in the Treatment of Pressure Ulcers. JMSCR 3(5): 5800-5809.
21. Begic Rahic, Jasmina Vunic, Sanja (2010) Application of Bioptron Light Therapy in Dermatology and Wound Healing. The European Dermatology 5: 57-60.
22. Bioptron light. Experience Significant Fine Lines and Wrinkle Reduction with Bioptron Anti Aging Light Therapy.

23. Changheon yoo, woong ku Lee, Osamu Kemmotsu (1993) Efficacy of polarized light therapy for musculoskeletal pain. Laser therapy 5: 153-157.

24. Feehan J, Soraya Patricia Burrows, Leonardo Cornelius, Alysie Malezis Cook, Kathleen Mikkelsen, et al. (2018) Therapeutic applications of polarized light: Tissue healing and immunomodulatory effects. Elsevier 116: 11-17.

25. Karu T (1999) Primary and secondary mechanisms of action of visible to near-IR radiation on cells. J Photochem. Photobiol B 49(1): 1-17.

26. Karu T (1988) Molecular mechanism of therapeutic effect of low-intensity irradiation. Laser Life Sci 2: 63-71.

27. Mester E, AF Mester, A Mester (1985) The biomedical effects of laser application. Lasers Surg Med 5(1): 31-39.

28. Monstrey S, H Hoeksema, H Saelens, K Depuydt, M Hamdi, et al. (2002) A conservative approach for deep dermal burn wounds using polarised-light therapy. Br J Plast Surg 55(5): 420-426.

29. Nixon AJ, Roth JE, Krook L (1991) Pulsed CO2 laser for intra-articular cartilage vaporization and subchondral bone perforation in horses. Proc. SPIE 1424.

30. Nobuta S, Sato K, Nakagawa T, Hatori M, Itoi E (2008) Effects of wrist splinting for Carpal Tunnel syndrome and motor nerve conduction measurements. Ups J Med Sci 113(2): 181-192.

31. Paugmali A, Vicenzino B, Smith M (2003) Hypoalgesia induced by elbow manipulation in lateral epicondylalgia does not exhibit tolerance. J Pain 4(8): 448-454.

32. Petkevičiūtė U, L Zorgeviča Pockeviča - IHS Conference abstract book (2018) Bioptron™ light therapy effects on surgical wound healing in dogs. https://hdl.handle.net/20.500.12512/97503 [Accessed 2 February 2020].

33. Reddy M, Gill SS, Kalkar SR, Wu W, Anderson PJ, et al. (2008) Treatment of pressure ulcers: a systematic review. JAMA 300(22): 2647-2662.

34. Ruiz Alberto Leguina, Kihan Rajnikant Raichura, Sarah Karis Tonks, Semira Kwabi, Claudia Leitner (2019) Treatment of non-atopic dermatitis with polarized UV-free polychromatic light: A case report. Open acces.Clinics and Practic 9: 1161.