Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2019 16(1):769-776. **OPEN ACCESS**

Polarized polychromatic non coherent light therapy versus aerobic training on peripheral arterial insufficiency

Asmaa Mohamed Mohamed[1], Hala Mohamed Ezz Eldin[1], Basant Hamdy El-Refay[2,3] and Abd El Aziz Eid Abd El Aziz Mercal[3]

[1]Faculty of Physical Therapy, Cairo University, **Egypt**
[2] Faculty of Applied Medical Sciences, King Khaled University, **Kingdom of Saudi Arabia**
[3]Vascular Surgery Department, El Matariya Teaching Hospital, Cairo, **Egypt**

***Correspondence:** asmaaemad2222@yahoo.com **Accepted:** 22 Sep. 2018 **Published online:** 14 Mar. 2019

Patients with peripheral arterial insufficiency are commonly presented by cramping or leg muscles pain during walking that is relieved by rest. In advanced condition there is rest pain in feet and toes. This study was conducted to investigate and compare between polarized light therapy versus aerobic exercise program on walking impairment questionnaire in peripheral arterial insufficiency patients. Forty males suffering from intermittent claudication because of peripheral arterial insufficiency were selected. Their ages were ranged from 40 to 50 years old. They were divided randomly into two groups: Exercise group and light therapy group. The exercise group consisted of 20 males who were treated with aerobic exercise program (treadmill exercise program), 3 times/week for two months. Each session lasted for 45-60 minutes, in addition to their medical treatment. The Light therapy group consisted of 20 males who received their medical treatment and received 20 min session of light therapy three times/week for two months. Walking impairment questionnaire (distance score, speed score, and symptoms of walking impairment) were assessed pre and post treatment for both groups. The results showed within group significant improvement in both groups in all measured variables. Significant differences were reported between groups post treatment in distance score and speed score,. So, it could be concluded that there is a good effect of aerobic exercise and polarized light therapy on walking impairment questionnaire in patients with peripheral arterial insufficiency.

Keywords: Peripheral arterial insufficiency., Polarized light therapy ,aerobic training, intermittent claudication

INTRODUCTION

Peripheral arterial disease (PAD) is a chronic atherosclerotic/occlusive disease of the aorta and its branches excluding coronary and cerebral arteries, commonly affecting the arteries supplying the lower limb. In most people PAD is without symptoms; however, others may experience pain at rest or with walking, this way limiting walking ability and physical activity levels. (Berger et al.,2013)

It was recently reported that the money-based PAD load is large, since the current management of PAD is centered on expensive surgical, with high rates of repeating time in a hospitals and repeat revascularization procedures (Mahoney et al., 2010). Lower extremity peripheral artery disease (PAD) affects 8.5 million of both sexs in the United States and >200 million people worldwide (Benjamin et al., 2017).

Most patients with PAD fall into 1 of 3 groups: Classic leg pain (10% to 30%), unexpected leg pain (20% to 40%) or without symptoms (nearly 50%). Formal testing to evaluate functional ability and shows significant weakness in patients with PAD even if without symptoms. Although most patients report leg signs of sickness other than classical leg pain, greater functional decline is related to greater extreme harshness of disease lower ankle brachial index (ABI) ,and increased numbers of cardiovascular event.(McDermott ,2015; McDermott et al ., 2001)

classically claudication defined as a painful, h urting, cramping, or tired feeling in the calves that appens during walking, does not begin at rest, do es not lessen if walking continues, and is relieved within 10 minutes or less when activity st op. This specific symptom presentation will be referred as classic claudication.(Olson et al., 2004).

People with PAD also have greater functional weakness, lower physical activity, and higher rates of ability to move around loss than people without PAD. (McDermott et al., 2002)

Exercise rehabilitation is an effective therapy to improve functional independence in both smoking and nonsmoking patients with PAD limited by intermittent claudication. Therefore, smokers with intermittent claudication are most important candidates for exercise rehabilitation because their relatively low baseline physical function does not impair their ability to regain lost functional independence to levels almost the same as nonsmoking patients with PAD. (Brass et al., 2007).

Bioptron light therapy system generate light characterized by polarization, polychromacy, incoherency and low-energy; polarized light, its waves move (oscillate) on parallel planes. Linear polarization by reflection (the multi-layer mirror system, Brewster mirror), is very efficient and reach a polarization degree of 95%. Bioptron light therapy system includes the wavelength range from 480 nm to 3400 nm, this spectrum contains the visible light range and a proportion of infrared radiation (the electromagnetic spectrum of Bioptron light does not contain ultraviolet radiation). Bioptron light is incoherent or "out-of-phase" light, or in other words, the light waves are not synchronized. (Monstrey et al., 2004).

The current study attempted to investigate the effect of Polarized light therapy as a new technique easy to use especially by old age persons versus traditional walking program in patients with peripheral arterial insufficiency.

MATERIALS AND METHODS

Subject and study design:

Forty men diagnosed as mild to moderate peripheral arterial disease with ABI (0.9-0.4) complain of intermittent claudication for at least 3 months participated in this study. They were selected from, El Matryia teaching hospital on 2017. Their ages ranged from 45-55 years old, with BMI scale ranged from (25 to 34.9 Kg/m2).

The exclusion criteria were Uncontrolled diabetic disease, Heart failure disease, Uncontrolled sever hypertension, Neurological disorder, Musculoskeletal disorder that interfere with exercise program, Leg or foot ulcers, Previous history or any sign of DVT.

The selected patients were diagnosed clinically by physicians and by duplex ultrasound. They were assigned randomly into two groups equal in number: exercise group and light therapy group. All subjects were instructed to stop smoking during the study time. After explanations of nature and goals of the study, a consent form was taken from all subjects who participated in this study the study was approved by Research ethical committee of Faculty of Physical Therapy, Cairo University with approval No. P.T.R.E.C/012/001266.

Outcome measures

Walking Impairment Questionnaire (WIQ) was developed and validated specifically for patients with claudication to assess treatment effects on claudication-limited walking ability. The questionnaire quantifies the patient's walking capability in terms of defined distances and speeds and rates the severity of claudication pain during usual walking activities. Changes in graded treadmill exercise performance correlate with changes in questionnaire scores, and the questionnaire responses are stable when repeated over time in control patients. (Regensteiner et al., 1990).

Firstly Weight and height of all subjects were measured to calculate body mass index. Walking impairment questionnaire (WIQ) was performed before starting program and after 2 months which is the intervention duration. Walking impairment questionnaire includes distance score, speed score and Symptoms of walking impairment.

Interventions:

Exercise Group

The patients in this group received physical therapy program in the form of treadmill walking. The first exercise training intensity was established using a graded treadmill test during the first exercise session and was defined as graded (zero %inclination) that brings on the start of claudation pain (i.e, level of 2 of 5 on claudiction scale) with initial speed set at 2.0 mph. Some patients have not been able to bear a treadmill speed of 2 mph and might need to start exercise program at a slower speed and progress according to his tolerance.

Participants would be asked to walk to a mild to moderate pain level (3-4 of 5 on claudication scale) then stop and sit down and have a rest until the claudication pain would be totally stopped up and then resumed walking.

The first goal of early exercise session was to had the participants piled up 15 minutes or extra of total treadmill time, not including warming –up and cool-down periods with ultimate goal to progress the participant to increasing exercise session of 45 minutes (include rest periods) as well as warming-up and cool-down of 5 minutes each for a total of 60 minutes per session series of the exercise training intensity should not happened during present session but would be initiated at the beginning of next session thus, participants would walk at steady work rate throughout all session without change.

It should be renowned that use of the claudication pain scale is an essential tool for monitoring indicative improvements in exercise performance and resulting in increase in exercise intensity if the patient would be able to walk at a workload for 8 minutes or more prior to experiencing moderate claudication pain (3-4/5), then the grade of speed would be improved by one-to-two-percent increment for the following training session.

once a patient was able to walk at a10.0 percent grade for 8 minutes or more, the speed was increased by 0.1-0.2 mph if a patient would able to walk for 8 minutes or more to 3.0 mph/10 percent grade, the grade is once more increase to 3.0mph if a patient is able to walk at 10.0 the grade is once more increase by 1to2percent increments the following training session up to 15grade percent .this would be followed by increasing in speed by 0.1to .02 mph increments for the following training session as tolerated. (The American Heart Association and American College of Cardiology, 2012 and American College of Sports Medicine. 2010).

Light therapy Group:

The patients of this group have been received their medical treatment and 3 session/week of polarized light therapy for 2 months. Each session was about 20 minutes divided into10 min on the affected leg at the site of claudication pain holding the device (at right angle 90°) perpendicular to the surface of the calf muscle and maintaining a distance of 10 cm from prone position and another 10 min on popliteal fossa, also from prone lying position.

Statistical analysis

Statistical analysis was conducted using SPSS for windows, version 22 (SPSS, Inc., Chicago, IL). Prior to final analysis, data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculations of the analysis of difference. The data were expressed as the mean+ standard deviation. Parametric statistical analysis was used for age, BMI, walking impairment questionnaire distance score, speed score and Symptoms of walking impairment. A P-value of less than $P < 0.05$ was taken as significant.

RESULTS

General Characteristics:

The current study was conducted on 40 males participants. They were assigned into two equal groups. Group (A) which is exercise group consisted of 20 participants with mean age and BMI values of 48.3±5.18 years and 30.46±1.85 kg/m2 respectively. Group (B) which is light therapy group consisted of 20 participants with mean age and BMI values of 45.9±3.64 years and 30.98±1.77 kg/m2 respectively. As indicated by the independent t test, there were no significant differences ($p>0.05$) in the mean values of age and BMI between both tested groups Table (1).

Walking Impairment Questionnaire Distance Score.

As presented in table (2) and fig (1), within groups' comparison of Walking Impairment Questionnaire Distance Score values showed significant improvement (P= 0.0001 in both groups). Comparing pre- and post-treatment values between the groups revealed non-

significant difference in the pre- treatment results (*P*=0.074) whereas in the post- treatment results, it showed significant difference in favor of the exercise group (*P*=0. 003).

Questionnaire Speed Score:

Within groups' statistical analysis of Walking Impairment Questionnaire Speed Score values showed significant improvement (P= 0.0001 in both groups). Between group comparison revealed no significant difference in the pre-treatment results (P=0.704) whereas in the post-treatment results, it showed significant difference in favor of the light therapy group (P=0. 0001), (table 3) and fig (2).

Table.1 Baseline characteristics of participants in both groups (A&B).

Items	Group A (exercise)	Group B (Light therapy)	Comparison		S
	Mean ± SD	Mean ± SD	t-value	P-value	
Age (years)	48.3±5.18	45.9±3.64	1.695	0.098	NS
BMI (kg/m^2)	30.46±1.85	30.98±1.77	-0.906	0.371	NS

*SD: standard deviation, P: probability, S: significance, NS: non-significant.

Table.2 Baseline characteristics of participants in both groups (A&B).

Items	Group A (exercise)	Group B (Light therapy)	Comparison		S
	Mean ± SD	Mean ± SD	t-value	P-value	
Age (years)	48.3±5.18	45.9±3.64	1.695	0.098	NS
BMI (kg/m^2)	30.46±1.85	30.98±1.77	-0.906	0.371	NS

*SD: standard deviation, P: probability, S: significance, NS: non-significant.

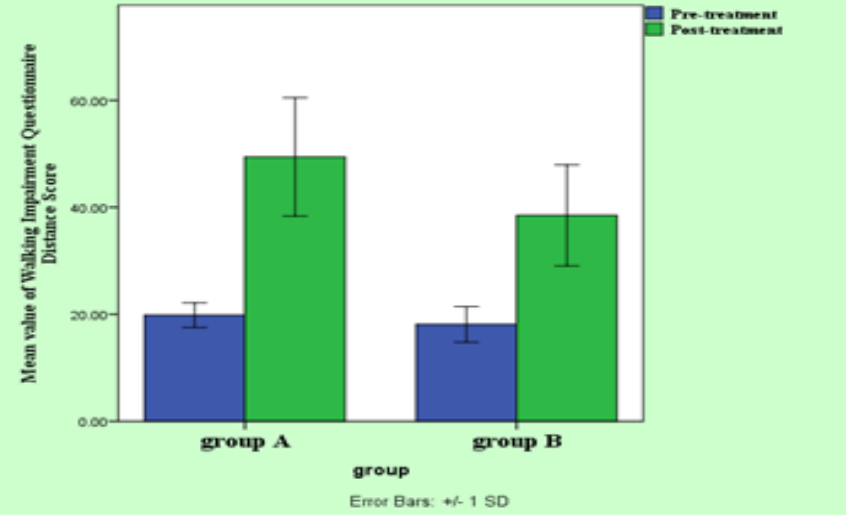

Figure.1 Mean values of Walking Impairment Questionnaire Distance Score pre and post-tests in both groups.

Table.3 Mean ±SD and p values of Questionnaire Speed Score pre and post-test at both groups.

Questionnaire Speed Score	Pre test	Post test	MD	% of change	p- value
	Mean± SD	Mean± SD			
Group A Ex group	12.47±2.91	22.21 ±3.55	-9.73	78	0.0001*
Group B Light therapy	12.11±2.84	31.77±3.81	-19.66	162	0.0001*
MD	-9.56	0.36			
p- value	0.0001*	0.704			

*Significant level is set at alpha level <0.05 SD: standard deviation
MD: Mean difference p-value: probability value

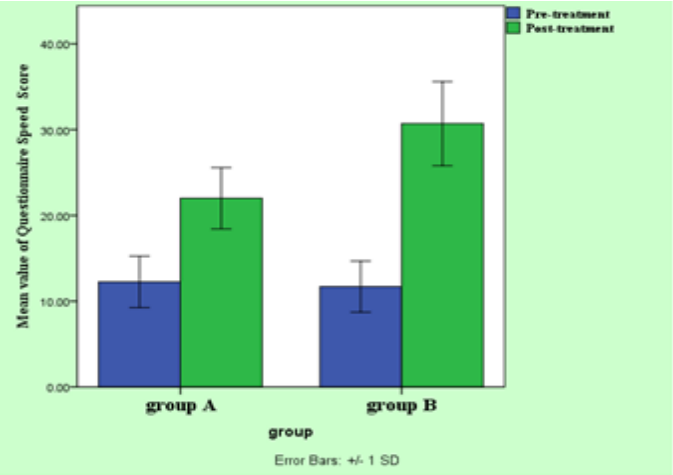

Figure.2 Mean values of Questionnaire Speed Score pre and post-tests in both groups.

Table4;Mean ±SD and p values of Symptoms of walking impairment Questionnaire Score pre and post-test at both groups.

Symptoms of walking impairment Questionnaire Score	Pre test Mean± SD	Post test Mean± SD	MD	% of change	p- value
Group A	21.78±0.78	23.1 ±0.45	-1.32	6.06	0.0001*
Group B	21.83 ±0.78	22.94±0.53	-1.11	5.08	0.0001*
MD	-0.05	0.16			
p- value	0.886	0.334			

*Significant level is set at alpha level <0.05 SD: standard deviation
MD: Mean difference p-value: probability value

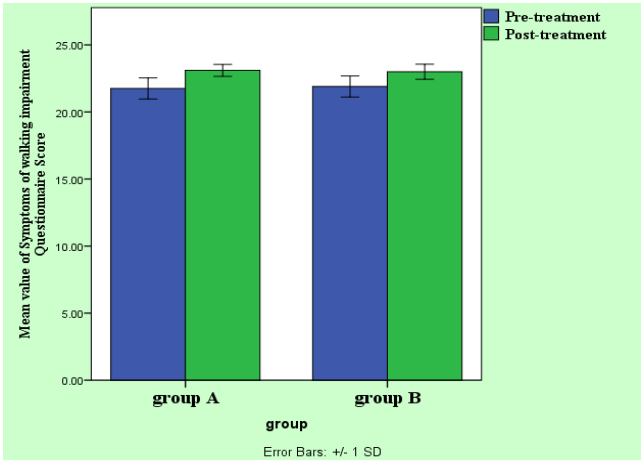

Figure.3;Mean values of Symptoms of walking impairment

Symptoms of walking impairment Questionnaire Score:

Regarding Symptoms of walking impairment Questionnaire Score, within group comparison revealed significant improvement (*P* = 0.0001 in both groups). Between group comparison revealed no significant difference in both pre- and post-treatment results (*P*=0. 0.886 and 0.334 respectively) as shown in table 4 and fig 3.

DISCUSSION

The aim of this study was to investigate and compare between the effect of polarized light therapy (PLT) and aerobic exercise on walking impairment questionnaire of patients with peripheral arterial insufficiency suffering from intermittent claudication pain. They were assigned randomly into two groups: exercise group and light therapy group. Both groups received their medical treatment. The exercise group received also a designed treadmill walking exercise program, while the light therapy group received polarized light therapy sessions. The intervention period was two months. Walking impairment questionnaire distance score, questionnaire speed score and symptoms of walking impairments were assessed before and after the intervention for both groups. The results of exercise group showed significant improvement in walking impairment questionnaire distance and speed score with percent of change 149%, 78% respectively and showed non- significant progress in symptoms score. On the other side, the light therapy group showed large progress in WIQ distance, speed score with percent of alter 112%, 162% respectively and non -significant progress in symptoms score.

The results of the exercise group agreed with (Gerhard-Herman et al., 2017) who managed 21 trials of walking on treadmill and reported the complete and total data for change in maximal treadmill walking distance, 15 (71%) reported more than 50% progress and five (21%) reported more than 100% progress in maximal treadmill walking distance. between the control groups, only one (5%) reported more than 50% progress and none reported more than 100% progress in maximal treadmill walking distance

(McDermott et al 2017) showed that gains from treadmill exercise in PAD are achieved somewhat gradually, with initial benefit followed only after about 4 wk of exercise and most of the treadmill walking benefit gained by 8 to 12 wk after the beginning of treadmill exercise therapy. They also confirmed that in a supervised treadmill exercise program, improvement in treadmill walking performance happens within 4 to 6 wk, while improvement in 6-min walk performance is more gradual. All of above trails confirm the results of exercise group with exercise time ranged from 3-6 month. In this study, the study time (exercise time) was 2 months only. This agreed with (Gardner et al., 2012) in their likely, randomized controlled trial. They verified that claudication onset time (COT) and peak walking time (PWT) raise through the first four months of exercise rehabilitation, with least change occurring during the final two months. However, absolute to the mileage walked during the program, increases in COT and PWT were only experiential during the first two months of the exercise program. They concluded that exercise-mediated gains in COT and PWT occur quickly within the first two months of exercise rehabilitation, and are maintained with additional training.

The clinical contact was that a rather small two-month exercise program may be better to a longer program to treat claudication because adherence is advanced, expenses associated with personnel and use of conveniences are lesser per patient, and additional patients can be educated for a given amount of personnel time and store utilization.

According to (McDermott, 2015)(Hamburg, Balady ,2011) (Hiatt et al.,2015),they all explained the biomechanical or biochemical mechanisms underlying the reimbursement of exercise therapy. Exercise-induced angiogenesis, enhanced nitric oxide (NO) reliant vasodilatation of the microcirculation, improved hemorheology, strong vascular inflammation, enhanced glucose and fatty acid metabolism in skeletal muscle, enhanced muscle bioenergetics and oxidative stress, enhanced peripheral nerve function .The mechanisms core the response to exercise training included improvements in Blood perfusion, Muscle metabolism , mitochondrial function, Peripheral nerve function and Walking effectiveness.

The results of light therapy group in this study supported by (Stasinopoulos et al., 2016) and (Medenica and Lens, 2003). They used polarized light therapy with wavelengths from 480 to 3200 nm, with 95% polarization using the principle of the Brewsters angle, and power of 2.4 J cm-2. They all completed that polarized light therapy have optimistic effects on curing of surgical wounds, burn wounds and open painful sores, as

well as ankle sprains and carpal tunnel disease.

The results of light therapy group also supported by (Lim et al., 2008 and Zhevago et al., 2004). They initiate that polarized light therapy act by lessening pro-inflammatory cytokines, rising anti-inflammatory cytokines, rising the T-helper lymphocyte population, rising IgM and IgA, and lessening immune complexes.

It is probable that polarized light (Bioptron light) alacrity up the cellular mechanisms and improves the blood supply, decreases pro inflammatory cytokines, and increases plasma level of anti-inflammatory and fibroblast growth factors, but research is needed to check its exact way of action (Zhevago, Samoilova, 2004) and (O'Connor et al., 2003) .

Also (Samoilova et al., 1998) explained the outcome of polarized light that exposure of a little skin area (400 cm2) of well volunteers to visible (400 - 2000 nm) incoherent polarized (VIP) light (degree of polarization > 95%) in medically helpful dose (4.8 - 9.6 J/cm2) causes a rapid structural-functional change of erythrocytes, leukocytes, and some plasma components in the whole circulating amount of blood. They recorded changes in lipid peroxidation (LPO) create content in erythrocyte membranes, deformability and viscosity of erythrocytes, phagocytotic activity of monocytes, cytotoxic activity of natural killer cells against target harmful cells, release of bactericidal proteins by granulocytes, plasma content of LPO-produces and pro-inflammatory cytokines, interleukine-1 beta and tumor necrosis factor-alpha, total anti-oxidant activity of plasma. The greater parts of these effects were of regulative nature, as their direction and amount depended on the early level of the studied parameters: the primarily low indices increased, while the primarily high ones decreased or remained unaltered. In 24 h the changes were still obvious in 33 - 62% of volunteers. They have shown a large similarity of the blood changes induced by the skin exposure and by the direct irradiation of blood in vitro. More than that, we got an event that the light-induced rapid modification of the entire circulating blood resulted from the direct effect upon it of transcutaneously irradiated blood, rather than of other systems of organism. as many pathological situation are characterized by an elevate in LPO processes, by turbulence in blood rheology, by decrease in normal fight and immunity, correction of their parameters with the VIP light might be a key way of its medically helpful effectiveness in many cases.

CONCLUSION

The results of this study support the good effect of aerobic exercise and polarized light therapy (bioptron) on Walking Impairment Questionnaire (WIQ) in patient with intermittent claudication pain from peripheral arterial insuffiency.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

The authors are extremely grateful to all participants and to Dr. Abd El Aziz Eid Abd El Aziz Mercal for his precious assistance in doing the Doppler assessment.

AUTHOR CONTRIBUTIONS

AMM designed and performed the experiments and also wrote the manuscript. HME, BHE and AEA performed *continuous guidance and suggestions* during the performance of experiments, data analysis and reviewed the manuscript. All authors read and approved the final version.

REFERENCES

Benjamin EJ, Blaha MJ, Chiuve SE, et al.,(2017): Heart disease and stroke statistics—2017 update: a report from the American Heart Association. Circulation. 127(1):143–152.

Brass EP, Jiao J, Hiatt W, et al., (2007): optimal assessment of baseline treadmill walking performance in claudication clinic trials. Vasc Med:12(2):97-103.[PubMed:9546975

Gardner AW, Montgomery PS, Parker DE , et al., (2012): Optimal exercise program length for patients with claudication. J Vasc Surg.;55(5):1346–1354.

Gerhard-Herman MD, Gornik HL, Barrett C, et al (2017): 2016 AHA/ACC guideline on the management of patients with lower extremity

peripheral artery disease: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol 69:1465-1508

Hamburg N M, Balady G J(2011).Exercise rehabilitation in peripheral arterial disease :functional impact and mechanisms of benefits circulation; 123:87-97.

Hiatt WR, Armstrong EJ, Larson CJ, et al., ,2015.Pathogenesis of the limb manifestations and exercise limitations in peripheral artery disease. Circ Res. 2015; 116:1527-39

Jeffrey S Berger, Brian G. Katona, W. Schuyler Jones, et al., 2013: Design and rationale for the Effects of Ticagrelor and Clopidogrel in Patients with Peripheral Artery Disease (EUCLID) trial Volume 175, p1-204, e1-e2

Lim JH, Lee J, Lee IS. Kim YJ, Song EY, et al., 2008.The effects of daily irradiation with polychromatic visible polarized light on human lymphocyte populations. Photomed Laser Surg 26 :361.

Mahoney EM, Wang K, Keo HH, Duval S, et al (2010) : Vascular hospitalization rates and costs in patients with peripheral artery disease in the United States. Nov;3(6):642-51.

McDermott MM, Ferrucci L, Tian L, et al., (2017): Effect of granulocyte-macrophage colony-stimulating factor with or without supervised exercise on walking performance in patients with peripheral artery disease: the PROPEL Randomized Clinical Trial. JAMA.318(21):2089–2098. Expert Searches Full Text Internet Resources

McDermott MM, Green land P, Liu K ,et al., (2001): leg symptoms in peripheral arterial disease: associated clinical characteristic and functional impairment.JAMA:286:1599-606.

McDermott MM, Greenland P, Liu K, et al (2002): The ankle brachial index is associated with leg function and physical activity: the Walking and Leg Circulation Study. Ann Intern Med.136(12):873–883.

McDermott MM.(2015): Lower extremity manifestations of -peripheral artery disease: the pathophysiologic and functional implications of leg ischemia. Circ Res.116:1540-50.

Medenica LA and Lens MA, 2003.The use of polarized polychromatic non-coherent light alone as a therapy for venous leg ulceration. Journal of Wound Care; 12: 1, 37-40.

Monstrey SA, Hoeksema HG and Depuydt KA, et al., (2004): The effect of polarized light on wound healing. European Journal of plastic Surgery; 24 (8): 3o4-310

O'Connor D, Marshall S, Massy-Westropp N,2003 Non-surgical treatment (other than steroid injection) for carpal tunnel syndrome. Cochrane Database Syst Rev.(1):CD003219.

Olson KW, (2004): Treat-Jacobson D. Symptoms of peripheral arterial disease: A critical review. J Vasc Nurs. 22(3):72–77.

Regensteiner JG, Steiner JF, Panzer RJ, Hiatt WR., et al., 1990.Evaluation of walking impairment by questionnaire in patients with peripheral arterial disease. J Vasc Med Biol.2:142-152

Samoilova K A, Obolenskaya K D , Vologdina A V ., et al 1998.Single skin exposure to visible polarized light induces rapid modification of entire circulating blood. 1. Improvement of rheologic and immune parameters. Proc. SPIE. Vol. 3569. P. 90-103.

Stasinopoulos D, Papadopoulos C. Lamnisos D, Stasinopoulos I,et al 2016.The use of Bioptron light (polarized, polychromatic, non-coherent) therapy for the treatment of acute ankle sprains. Disabil Rehabil 4 :1.

The American Heart Association and American College of Cardiology (AHA/ACC: (2012): Guidelines for the Management of Patients With Lower Extremity Peripheral Arterial Disease

Zhevago N A , Samoilova K A, Obolenskaya K D,2004.The regulatory effect of polychromatic (visible and infrared) light on human humoral immunity. Photochemical and Photobiological Sciences Vol. 3, №.1. – P.102-108.