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Effect of Bioptron Light Therapy on Pregnancy Related Carpal Tunnel Syndrome

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Abstract

Background: Pregnancy related carpal tunnel syndrome (CTS) is the most frequent mononeuropathy during pregnancy that means compression neuropathy of the median nerve at the level of the wrist. Physical therapy intervention can help in CTS management.

Aim of Study: The purpose of this study is to investigate the effect of bioptron light therapy on pregnancy related CTS.

Patients and Methods: 62 pregnant women with CTS were recruited and randomly assigned into two groups equal in number. Group (A) included 31 women who treated with Bioptron light therapy for 10 minutes per session, 3 sessions per week, for 4 weeks and wore wrist bracein addition to advice and patient education. Group (B) treated with the same program for group A excluding bioptron light therapy. Assessment of all females were done before the treatment program as well was after 4 weeks of treatment through measuring the nerve conduction studies (NCS) using electromyography.

Results: There was a significant improvement in motor conduction velocity (MCV) post treatment in group (A) (p=0.001). While there was no statistical significant difference of MCV post-treatment in group (B) (p=0.301). There was a statistical significant decrease of distal motor latency (DML) in both groups A and B post treatment (p=0.001) and (p=0.004) respectively in favor to bioptron light therapy group.

Conclusion: Using bioptron light therapy in the management of CTS during pregnancy has superior effect more than using wrist brace and advice only.

Key Words: Carpal tunnel syndrome – Pregnancy – Bioptron light therapy – Wrist brace.

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Introduction

CARPAL tunnel syndrome (CTS) is a symptomatic compression neuropathy ofthe median nerve at the level of the wrist, characterized by hand pain, numbness, and tingling in the distribution of the median nerve (thumb, index, middle finger, and the radial side of the ring finger) and a reduction in grip strength and hand function. The severity of symptoms can be clinically categorized into mild,-moderate, and severe **[1]**. The condition affects approximately 3% of the population, more commonly-women. Pregnancy related CTS is the most frequent mononeuropathy during pregnancy with reported incidence varies widely and ranges from 0.8% to 70% depending on the diagnostic method and thephysician **[2]**. NCS has been showed as the gold standard in the diagnosis of CTs. It measures sensory and motor nerve action potential which determines the severity of median nerve entrapment **[3]**. The first-line management should include patient education as limiting repeated stressful wrist movements. Physical therapy management is usually indicated for mild and moderate cases, therapeutic ultrasound and low level laser therapy improved the symptoms within 4 weeks **[4]**. Bioptron phototherapy acts as a "sterile" trigger on human in vitro isolatedperipheral blood mononuclear cells (PBMCs), affecting their cytokine production and driving the immune response towards an anti-inflammatory/ reparative profile and representing a non-pharmaceutical and non-invasive option for several clinical conditions **[5]**. Bioptron is a new therapeutic modality which efficacy has been investigated for the following conditions: Burns, lateral epicondylitis, post surgical healing, and ulcers **[6]**. This study aimed to investigate the effect of bioptron light therapy on pregnancy related CTS.

Patients and Methods

Study design:

This study was conducted as a prospective double-blinded randomized control trial. The institutional review board at the Faculty of Physical Therapy, Cairo University, provided ethical approval for this study [012/003870]. It was also prospectively registered at clinicaltrials.gov with the identifying number [NCT05904561]. It was conducted between April 2023 and August 2023. Before starting, the study's aims and procedures were explained to the legal guardians of all participants. After receiving detailed explanations of the study goals, methods, and withdrawal policies, all participants signed a written consent form.

Subjects:

62 pregnant women with complain of CTS participated in this study. They were selected from outpatient clinic, Tahta General Hospital, Sohag, Egypt. All women were included in this study if they fulfill the following criteria: Had symptoms of numbness, tingling, weakness, and pain in the hands for at least 1 month, had positive result fore Phalen as well as Tinel's provocation test, their age ranged from 25-35 years, their body mass index (BMI) was $\leq$35 kg/m^2. While women who met one of the following criteria were excluded from the study: History of neurologic disease, hand surgery, hand trauma, diabetes mellitus, cervical spondylosis, osteoarthritis of cervical spine orwrist joint, chronic renal failure, heart failure, connective tissue disorders.

Randomization and binding:

All women were randomly divided into two equal groups (A and B) by using sealed envelope methods. Written cards of bioptron light therapy or wrist brace were put in closed envelopes and another researcher who blinded on the study procedure was asked to choose one card. According to which card was chosen, women were allocated to their group. Group (A) consisted of 31 patients suffering from CTS pain who treated with bioptron light therapy on the affected hand, 3 sessions per week for 4 weeks in addition to wrist brace and advice, Group (B) consisted of 31 patients suffering from CTS pain who treated with wrist brace and advice only.

Assessment Procedures:

Nerve conduction studies:

The room temperature was maintained around 30-31°C. Two surface electrodes used for recording as G1 was placed over abductor pollicis brevis muscle and G2 was placed over the first metacarpal phalangeal joint, then median nerve was stimulated between the tendons of flexor carpi radial is and Palmaris long us at a distance of 7cm from the recording electrode This procedure was repeated for each participant female in both groups (A&B) before and after 4 weeks of the treatment protocol **[7].**

Treatment Procedure:

A- Advice:

All participants in both groups followed the following advice: Avoid repetitive hand motions, holding onto vibrating tools, heavy grasping, and positioning or working with wrist bent down and out; quit smoking; lost weight if overweight; and reduce caffeine intake **[8].**

B- Wrist brace:

All participants in both groups A&B wore a wrist brace that kept the wrist in a neutral position, not bent back or bent down too far for four weeks. Patients were instructed to wear the brace day and night only allowed to don off for personal hygiene **[9].**

C- Bioptron light therapy:

All participants of the study group were treated by bioptron light therapy for 10 minutes per session, 3 sessions per week, for 4 weeks. BIOPTRONG, Wollerau, Switzerland was used to emit a polarized, polychromatic, non-coherent, low energy bioptron light on the wrist area, patient was saton comfortable chair with the hand placed on an armrest in an extended and supinated position. Firstly, the skin over the wrist area was exposed and cleaned by alcohol to achieve maximal penetration of light. Then, the bioptron device was held perpendicular to the surface of the treated area, at a distance 10cm.

Data analysis:

Data were expressed as mean ± SD. Unpaired *t*-test was used to compare between subjects characteristics and chi square test for comparison of the affected side of the two groups. Shapiro-Wilk test was used for testing normality of data distribution. MANOVA was performed to compare within and between groups' effects for measured variables (motor conduction of an electrical impulse through median nerve at wrist level). Statistical package for the social sciences computer program (version 20 for Windows; SPSS Inc., Chicago, Illinois, USA) was used for data analysis. *p*-value less than or equal to 0.05 was considered significant.

Normality test:

Data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. Shapiro-Wilk test for normality showed that the measured variables were normally distributed ($p>0.05$).

Results

Subject characteristics:

Table (1) showed that there were no significant difference between the mean value of subjects age, weight, height, BMI and pregnancy week of both groups (p=0.536, 0.533, 0.219, 0.157 and 0.941) re-

spectively. The number (%) of affected side of both groups was 31 (100%) right side, there were no significant difference between both groups (p=1).

Table (1): Demographic data of subjects of both groups.

Demographic data	Group A Mean ± SD	Group B Mean ± SD	*t*-value	*p*-value
Age (years)	30±3.5	29.3±3.6	0.62	0.536
Weight (kg)	79.1±6.7	0.2±4.4	–0.63	0.533
Height (cm)	159.1±5	161±4.9	–1.25	0.219
BMI (kg/m2)	31.6±1.6	31±1.3	1.44	0.157
Pregnancy week	31.6±2.4	31.5±1.9	0.07	0.941
Affected side: Right	N (%) 31 (100%)	N (%) 31 (100%)	$\chi 2$=0	1

SD: Standard deviation. $\chi 2$: Chi square. *p*-value: Significance.

Overall effect of treatment on measured variables:

MANOVA was conducted to investigate the effect of treatment on the measured variables. There was significant interaction effect of (treatment * time) (p=0.001), Also there was significant effect of treatment (p=0.001), and there was significant effect of time (p=0.001) (Table 2).

Table (2): MANOVA table for the effect of treatment on the measured variables.

	MANOVA table		
	F-value	*p*-value	n^2
Interaction effect (treatment * time)	1328	0.001	0.99
Effect of time	1654.5	0.001	0.99
Effect of treatment	15.7	0.00	0.775

F-value: Mixed MANOVA *F*-value.
p-value: Significance.
n^2: Partial eta square.

The impact of treatment on median nerve motor nerve conduction study:

a- Motor conduction velocity:

Within group comparison:

The mean values ± SD of median nerve MCV pre and post-treatment of group A were 56.8±3.6 and 61.1±3.5 m/s respectively. There was a statistical significant increase of median nerve MCV by 7.6% post-treatment (p=0.001). The mean values ± SD of median nerve MCV pre and post-treatment of group B were 57.5±4.7 and 57.6±4.8 m/s respectively. There was no statistical significant difference of median nerve MCV post-treatment (p=0.301), it was increased by 0.17% (Table 3).

Between groups comparison:

There was no statistical significant difference in the mean values of median nerve MCV pre treatment between both groups (p=0.570), while there was statistical significant difference post treatment (p=0.012); mean values of median nerve MCV were increased more significantly in group A than group B (Table 3).

b- Distal motor latency:

Within group comparison:

The mean values ± SD of median nerve DML pre and post-treatment of group A were 3.9±0.9 and 3.7±0.9 milliseconds respectively. There was a statistical significant decrease of median nerve DML by 5.1% post-treatment (p=0.001). The mean values ± SD of median nerve DML pre and post-treatment of group B were 3.8±0.6 and 3.66±0.6 milliseconds respectively. There was a statistical significant decrease of median nerve DML by 3.7% post-treatment (p=0.004) (Table 3).

Between groups comparison:

There was no statistical significant difference in the mean values of median nerve DML pre treatment between both groups (p=0.499), also there was no statistical significant difference post-treatment (p=0.837) (Table 3).

Table (3): Mean ± SD of median nerve SCV and PSL pre and post treatment of both groups.

Median nerve	Group A Mean ± SD	Group B Mean ± SD	Mean difference	*F*-value	p-value[1]
MCV (m/s):					
Pre-treatment	56.8±3.6	57.5±4.7	–0.7	0.33	0.570
Post-treatment	61.1±3.5	57.6±4.8	3.5	6.97	0.012*
% of change	7.6%	0.17%			
p-value	0.001*	0.301			
DML (millisecond):					
Pre-treatment	3.9±0.9	3.8±0.6	0.1	0.47	0.499
Post-treatment	3.7±0.9	3.66±0.6	0.04	0.04	0.837
% of change	5.1%	3.7%			
p-value	0.001*	0.004*			

MCV: Motor conduction velocity.
DML: Distal motor latency.
SD : Standard deviation.
p-value[1]: Level of significance within group.
p-value: Level of significance between groups.
*: Significant.

Discussion

CTS syndrome is one of the most musculoskeletal system complaints among pregnant women, more common affects dominant hand and caused tingling, numbness and pain in the thumb, middle and index fingers as well as in the radial side of the ring finger [10]. The motor symptoms represented as weakness in the thenar musculature and reduction of discriminative pressure and tactile sensibility may occur [11]. These symptoms affecting pregnant women and interfere with the sleep quality [12]. Prevalence of CTS in pregnant women ranging from 2.3 to 62% as mentioned in literature [13]. The prevalence increases in the third trimester [14] and around half of pregnant women still suffer of symptoms after one year of labor [15].

Bioptron is a new therapeutic modality which efficacy has been investigated for many conditions including burns, CTS, lateral epicondylitis, postsurgical healing, and ulcers [16]. The purpose of this study was to investigate the effect of bioptron light therapyon pregnancy related CTS.

The result of this study revealed that both control and study groups showed significant improvement in DML in favor to group A with a percentage of improvement of 5.1% and 3.7% for group A and B respectively, while only group A showed statistical significant increase of median nerve MCV post-treatment (p=0.001).

Bioptron light mechanism of action depends on bio-stimulative effects: When applied to the skin, it stimulates light-sensitive intracellular biomolecules. This initiates cellular chain reactions and also triggers secondary responses not only limited to the treated skin area but can affect the whole body [17]. Bio-positive effects attributed to bioptron include reducing plasma levels of pro-inflammatory cytokines, increasing anti-inflammatory cytokine levels and fibroblast proliferating factors and modifying lymphocyte proliferation [18].

The results of our study are supported by Schaser et al., who found that bioptron light therapy in addition to cryotherapy was effective in acute ankle sprains than cryotherapy alone as it reduced the degree of pain via VAS and decreased edema [19].

The findings of the current study are in line with Dimitrios and Stasinopoulos [20], they studied the bioptron light therapy in the treatment of pregnancy related CTS. Bioptron light, 480-3400 nm; 95% polarization; 40 m W/cm^2; and 2.4 J/cm^2, was administered perpendicular to the carpal tunnel area. The irradiation time for each session was six minutes at an operating distance of 5-10 centimeter from the carpal tunnel area, twice a day, five days per week for two weeks. Pain, paresthesia and pinch strength were evaluated at the end of treatment, week 2, and one-month, week 6, after the end of treatment using the VAS and the pinch dynamometer respectively. There were significant decrease in pain and paresthesia and significant improvement in pinch strength. The results suggested that bioptron light is a reliable, safe, and effective treatment option in pregnant patients with CTS.

Furthermore, bioptron light therapy was applied as monotherapy in the study conducted by Stasinopoulos et al. [21]. He assessed the efficacy of bioptron light therapy in the treatment of idiopathic CTS. Twenty-five patients with mild to moderate CTS lasting more than three months received bioptron light three times weekly for four weeks. Outcome measures used were the participants' global assessments of nocturnal pain and paresthesia at four weeks and six months, respectively. The results showed that nocturnal pain and paresthesia associated with CTS improved during bioptron light treatment. However, due to the absence of control group, it wasn't possible to conclude that these findings were due to the bioptron light treatment intervention itself rather than to probable natural improvements in symptoms. Furthermore, he evaluated symptoms improvement only subjectively and no electrophysiological studies were included.

Moreover, Zlatkovic [22] evaluate the impact of bioptron lighttherapy (polarized, polychromatic, noncoherent, low-energy radiation) combined with cryotherapy and optimal exercises in patients after distal radial fracture (DRF) and to investigate the prevention of complex regional pain syndrome (CRPS). The study included patients with DRF, they were randomly assigned into two age matched groups: Group 1 n=26 who were treated with non -steroid anti- inflammatory drugs, exercise and cryotherapy and group 2 n=26 who treated with the same protocol as group 1 but received bioptron (polarized polychromatic non-coherent light). All patients were evaluated at days D0, 7, 15 for pain using VAS and D7, D15 for wrist rang of motion (supination and pronation) and at D15 for hand fist forming capacity and follow-up for CRPS induced complications for 6 months after completion of therapy. We found that bioptron light therapy significantly accelerated pain relief and improved supination inelderly patients, compared with conventional treatment (cryotherapy and optimal exercises) alone. In addition, we found that the risk of CRPS could be minimized with bioptron light therapy, providing evidence that bioptron light therapy has significant benefits when used in combination with already existing therapy options for elderly patients with DRF.

Limitations of the study:

This study was limited by the absence of patient follow-up after finishing treatment program to ensure the long term effect of bioptron on CTS. As well, the study was limited by the daily living activities of the participants which might affect the results of the study.

Ethical clearance:

Ethical clearance has obtained from the ethical committee of scientific research of the faculty of Physical Therapy, Cairo University (No: P.T.REC/012/003875).

Conflict of interest:

There was no conflict of interest to conduct this study.

Conclusion:

Bioptron light therapy added to wrist brace and advice has positive impact on pregnancy related carpal tunnel syndrome.

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تأثير العلاج الضوئى بالبيوبترون على متلازمة اختناق العصب الأوسط لرسغ اليد اثناء الحمل

الخلفية: متلازمة النفق الرسغى من اكثر الاعراض شيوعاً فى الشهور الأخيرة فى الحمل وهى الم وتنميل فى اليد يشمل اصبع الابهام والسبابة والوسطى والجزء الخارجى لاصبع الخنصر ويشمل اعراضه ضعف في قبضة اليد .

الهدف: قد هدفت هذه الدراسة الى دراسة تأثير البيوبترون على متلازمة النفق الرسغى اثناء الحمل.

طرق واساليب البحث : تم اختيار السيدات الحوامل اللاتى يعانين من متلازمة النفق الرسغى بدرجة بسيطة الى متوسطة وتقسيمهن عشوائياً إلى مجموعتين متساويتين فى العدد: المجموعة الضابطة و وهؤلاء التزمن بارتداء جبيرة الرسغ وتقليل الاعمال التى تتطلب مجهود لمفصل الرسغ لمدة شهر كامل ومجموعة الدراسة واللاتى تلقين العلاج بجهاز البيوبترون لمدة شهر بمعدل ثلاث جلسات أسبوعياً مدة الجلسة عشرة دقائق بالإضافة إلى نفس العلاج المقدم للمجموعة الضابطة.

النتائج: اوضحت نتائج الدراسة وجود تحسن ذو دلالة إحصائية فى كلا المجموعتين ولكن كان التحسن فى مجموعة الدراسة الذى استقبل البيوبترون بشكل اكبر عنه فى المجموعة الضابطة.

الاستنتاج: يمكن ان نستخلص من هذه الدراسة ان للبيوبترون تأثير كبير وواضح فى علاج متلازمة النفق الرسغى اثناء الحمل.