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Effect of Cryotherapy versus Transcutaneous Electrical Nerve Stimulation on Patients with Hypertension

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Abstract

Background: One billion of the world's population has hypertension, resulting in four million deaths per year. Data on the prevalence of hypertension in the Arab world are very limited. Only 13 studies were identified in the literature from 10 Arab countries. The overall estimated prevalence of hypertension was 29.5%, which indicates a higher prevalence of hypertension among Arab compared to people from the USA (28%) and sub-Saharan African (27.6%).

Aim of Study: Of this study was to investigate the effect of cryotherapy versus transcutaneous electrical nerve stimulation on hypertensive patients.

Subjects and Methods: Forty men were recruited from Disuq General Hospital, Disuq, Kfr El-Shiekh. They were assigned into two equal groups. Their ages ranged from 40 to 50 years. Group (A) with mean age (46 ±3.5) years and Group (B) with mean age (47.8±2.7) years. Group (A) received ice application for 30 minute three times per week for 4 weeks. Group (B) received TENS application for 30 minute three times per week for 4 weeks. Blood pressure was measured before and after every session as acute effect of applications and also was measured after 2 weeks and after 4 weeks as a chronic effect.

Results: As an acute effect: In group (A) there were significant differences in systole except in 3 rd, 4th and 6th sessions while there were significant differences in diastole except 7th session. In group (B) there were significant differences in systole and diastole.

As a chronic effect: In group (A) there were no significant differences in systole while there were significant differences in diastole. In group (B) there were significant differences in systole and diastole.

Conclusion: Ice and TENS applications had significant effect on improving hypertension but in favor to TENS application.

Key Words: *Cryotherapy – Transcutaneous electrical nerve stimulation – Hypertension.*

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Introduction

HIGH blood pressure or hypertension means high blood pressure (tension) in the arteries. Normal blood pressure is 120/80; blood pressure between 120/80 and 139/89 is called "pre-hypertension", and a blood pressure of 140/90 or above is considered high **[1]**.

Hypertension is a common health problem in Egypt. It has a high prevalence, whereas its rates of awareness, treatment and control are low. In 60% of patients, hypertension is complicated by the presence of other cardiovascular risk factors, this adds to increased cardiovascular morbidity and mortality. Management of hypertension in Egypt is not easy because of treatment costs-a common cause of interruption of therapy-, inadequate physician training and inefficient primary health care system. Measures to improve blood pressure control include better physicians education and a viable health care system **[2]**.

Hypertension is due to a derangement of sympathetic and parasympathetic cardiovascular regulation is one of the most widely accredited and tested hypotheses in cardiovascular research. In animal models of hypertension, both an increased sympathetic nerve activity and a reduction of vagal cardiac tone associated with and responsible for the appearance and maintenance of high blood pressure **[3]**.

Several articles have dealt with the importance and mechanisms of the sympathetic nervous system alterations in experimental animal models of hypertension. With this background, they examine interventions of sympathetic deactivation as a mode of antihypertensive treatment. Particular emphasis is given to the background and results of recent

therapeutic approaches based on carotid baroreceptor stimulation and radiofrequency ablation of the renal nerves [4].

It is well known that reducing tissue temperature changes nerve conduction. However few studies have compared the effect of different cold modalities on nerve conduction parameters. All modalities were effective in reducing skin temperature and changing sensory conduction at a physiological level that is sufficient to induce a hypoalgesic effect [5].

Resistant hypertension treatment requires an adequate and intense therapeutic approach. However, the results are not always satisfactory despite intensive treatment. Of the different pathophysiological mechanisms involved in the pathogenesis of resistance hypertension, sympathetic overstimulation and therapies that block the sympathetic system have been widely studied. These approaches, however are invasive and expensive. Another possible approach is by Transcutaneous Electrical Nerve Stimulation (TENS) to inhibit primary afferent pathways [6].

Subjects and Methods

Subjects:

Forty men subjects with essential hypertension involved in this study. Their ages ranged from 40 to 50 years with BMI (25-29.9kg/m^2). They are selected from out-patient clinic of Disuq General Hospital. The study was conducted at Disuq General Hospital from September to October 2018. They are assigned randomly in two groups:

- Group A received ice pack application paravertebral 30 minute three times per week for four weeks.
- Group B received TENS application paravertebral 30 minute three times per week for four weeks.

Blood pressure was measured before and after every session as acute effect of applications and also was measured after 2 weeks and after 4 weeks as a chronic effect.

Ethical consideration:

The purpose, nature and potential risks of the study were explained to all patients, and a consent form was taken from all participants as an agreement to be included in the present research study. The study was reviewed and approved by Ethical Committee of Faculty of Physical Therapy, Cairo University.

Inclusion criteria:

All patient with essential hypertension stage 1 (140/159-90/99mmhg) systolic and diastolic respectively and should be on optimal medical conditions. It is preferred to be in the same dose of medical treatment throughout the period of session.

Exclusion criteria:

Subjects were excluded if they have:

1- Sever pulmonary disease (restrictive lung disease or with obstructive lung disease).
2- BMI >29.9kg/m^2.
3- Blood pressure >159/99 or <140/90mmHg.
4- Patients with pacemaker.
5- Uncontrolled diabetes.
6- Unstable cardiovascular conditions those with a known history of ischemic attacks, stroke and congestive heart failure.
7- Neuropsychological disorders.
8- Major organ failure.

Material:

- *Measuring equipment:* BMI was calculated using formula "weight (kg)/height (m^2)" [7] as weight and height measured by (OCZ-M1001 height and weight scale-medical scale 100-200kg). Blood pressure was measured by Mercury Sphygmomanometer and Stethoscope.
- *Treatment tools:* Plinth or Bed are used for applying ice pack and TENS from prone position. Ice pack was wrapped in a towel and use physiomed device (PHYSIODYN-DUO) to apply TENS. Time was measured using stop watch.

Evaluative procedure:

- Blood pressure was measured before and after every session as acute effect of applications and also measured after 2 weeks and after 4 weeks as a chronic effect.

Before the blood pressure measurement, the following conditions should be:

- Patient avoided from eating, drinking (anything else than water), smoking and taking drugs that affect the blood pressure one hour before measurement.
- The bladder should be empty.
- Patient set quietly for about 5 minutes.
- Patient removed outer garments and all other tight clothes.

- The sleeve of shirts, blouses, etc. rolled up so that the upper right arm was bare.
- Blood pressure was measured in a quiet room with comfortable temperature.
- Receiving a session was at the same time of the day.
- The blood pressure measurement recorded in the blood pressure data recording form.

Treatment procedure:

- Group (A) received ice pack session thirty minute on paravertebtrae from C7 to L2, three times per week.
- Group (B) received TENS session thirty minute on paravertebtrae from C7 to L2, three times per week.

Application of cold pack:

- Cold packs which was a vinyle casing filled with silica gel applied for 30 minute.
- Method of application: Dampen a towel with warm water, wring out excess water, fold in half width-wise and placed cold pack on towel. It was placed on patients and covered with dry towel to retard warming.
- Treatment temperature: Packs are maintained in refrigerated unit at 0F-10F and the method of heat transmission was conduction [7].

Precautions and contraindication:

- Impaired temperature sensation.
- Open wound.
- Cognitive changes.
- Cold hypersensitivity.
- Cold intolerance.
- Disease impaired temperature sensation [8].

Application of TENS:

- Patient received low frequency (10HZ) TENS session for 30 minute paravertebral from C7 to L2 three times per week. The intensity increased from zero until the perceived sensation reaches the maximum sensory threshold without pain or discomfort or involuntary muscle contractions.
- Place of electrodes: Two channels (4 electrodes). The arrangement was parallel on each side of the C7 (channel 1) and L2 (channel 2) vertebral spinous processes.
- *Before application:*
  - Marking the correct location using a dermatographic pencil and cleaning the skin.
- *Contraindication:*
  - Patient with demand type pacemaker or over chest of patient of cardiac disease.
  - TENS not applied over eyes, laryngeal or pharyngeal muscles, head and neck of patient following cerebral vascular accident or with epilepsy.
  - TENS not applied to mucosal membrane.

Results

This study is concerned with investigation of the effect of cryotherapy and transcutaneous electrical nerve stimulation on hypertensive patients.

General characteristics of the subjects:

In this study, forty patients were participated in this study, they were assigned randomly in two equal groups; Group A received cryotherapy and Group B received TENS paravertebral three times per week for four weeks. Blood pressure was assessed before and after every session (12 sessions) to analyze the acute effect of applications and also was measured after 2 weeks and after 4 weeks as a chronic effect.

The mean age of group A were (46±3.5) years, weight (81.4±4.7) kg, height (169.6±1.7) cm and BMI (28.2±1.6) kg/m^2. The mean age of group B were (47.8±2.7) years, weight (79.4±2.8) kg, height (168.8±1.5) cm and BMI (28.3±1.1) kg/m^2, as shown in (Table 1) *t*-test revealed that no significant difference between two groups in their mean age, weight, height and BMI where $p>0.05$.

Table (1): General characteristics of subject.

General characteristics	Age (yrs) Mean ± SD	Weight (kg) Mean ± SD	Height (cm) Mean ± SD	BMI (kg/m^2) Mean ± SD
Group A	46±3.5	81.4±4.7	169.6±1.7	28.2±1.6
Group B	47.8±2.7	79.4±2.8	168.8±1.5	28.3±1.1
t-value	–1.8	1.63	1.67	–0.160
p-value	0.077	0.111	0.102	0.874

*SD: Standard Deviation.
p : Probability.

Chronic effect of treatment on systolic blood pressure:

As demonstrated in (Table 2), the mean ± SD of systolic blood pressure in group A for three measurement before and after the first, 6 th and 12th sessions were (151.3±7.4), (148.3±5.6), (150.6±5.7) and (149.3±8.1), (148.3±7.2), (149±5.7) respectively. There was statistical significant difference in systolic blood pressure among the three measurements pre-session (p=0.001), while there was no significance post-session (p=0.080).

Group B, the mean ± SD of systolic blood pressure for three measurement before and after the first, 6th and 12th sessions were (151.6±7.3), (150.7±5.2), (148.7±4.5) and (148.5±7), (149±7.4), (144.7±4.9) respectively. There was statistical significant difference in systolic blood pressure among the three measurements pre-session and post-session (p=0.001).

Table (2): Chronic effect of treatment on systolic blood pressure for each session.

Diastolic	Group A		Group B	
	Pre-session	Post-session	Pre-session	Post-session
• 1st session (measure 1)	151.3±7.4	149.3±8.1	151.6±7.3	148.5±7
• 6th session (measure 2)	148.3±5.6	148.3±7.2	150.7±5.2	149±7.4
• 12th session (measure 3)	150.6±5.7	149±5.7	148.7±4.5	144.7±4.9
• f-value	26.6	2.7	12.8	7.8
• p-value	0.001	0.080	0.001	0.001

Chronic effect of treatment on diastolic blood pressure:

As demonstrated in (Table 3), the mean ± SD of diastolic blood pressure in group A for three measurement before and after the first, 6 th and 12th sessions were (94.3±3.1), (92±3.6), (90.7±3.5) and (93.3±3.6), (91±4), (89.7±3.4) respectively. There was statistical significant difference in diastolic blood pressure among the three measurements pre-session and post-session (p=0.001).

Group B, the mean ± SD of diastolic blood pressure for three measurement before and after the first, 6th and 12th sessions were (94.7±3.7), (92.3±2.7), (91.7±1.9) and (93±4), (91±2.7), (90±1) respectively. There was statistical significant difference in diastolic blood pressure among the three measurements pre-session and post-session (p= 0.001).

Table (3): Chronic effect of treatment on diastolic blood pressure for each session.

Diastolic	Group A		Group B	
	Pre-session	Post-session	Pre-session	Post-session
1st session	94.3±3.1	93.3±3.6	94.7±3.7	93±4
6th session	92±3.6	91±4	92.3±2.7	91±2.7
12th session	90.7±3.5	89.7±3.4	91.7±1.9	90±1
f-value	15.7	11.8	15.5	8.2
p-value	0.001	0.001	0.001	0.001

Discussion

In recent decades, hypertension has become very common and costly. Adequate control requires several drugs, and in many cases, treatment is not successful. Sympathetic nervous system inhibition by renal denervation and central inhibition have significant effects in reducing blood pressure, however. These treatments are costly and invasive. Another type of sympathetic nervous system inhibition can also be noninvasively achieved by electric current. Therefore, the application of TENS may be a new therapeutic option for treating hypertensive patient [9].

Ice pack, ice massage and cold water immersion are effective in reducing skin temperature and changing sensory conduction at a physiological level that is sufficient to induce a hypoanlgesic effect.

Maintained skin cooling may also decrease the temperature of any underlying muscles and conduction velocity of underlying nerve fibers. In peripheral nerves, the conduction velocity of all myelinated fiber groups falls gradually with decreasing temperature, until conduction is blocked. The relationship between conduction velocity and temperature is roughly linear [10].

This study was conducted to find out the effect of cryotherapy versus transcutaneous electrical nerve stimulation on hypertensive patients.

Martin J.F. et al., [11] agreed with current study, as they concluded that TENS causes a reduction of blood pressure after applying of TENS for 30 minute for 30 days on patients which their age ranged from 40 to 70 years.

The result of our study agreed with the results of Mooventhon A., [12], who found that ice application on head and spine caused cardiovascular changes. His results showed significant reduction in SBP and DBP. In current study there were significant differences in SBP in some sessions and in DBP in most sessions.

The current results were similar to results reached by Shetty G. B. et al., [13] as they reported that, cold spinal bath reduces sympathetic tone and shifts sympathovagal balance towards vagal dominance and hence support the claim that cold spinal bath can be effectively used in lowering the blood pressure in hypertensive patients.

Also Sartori S.A. et al., [14] supported current results as they concluded that low frequency TENS decreases sympathetic nervous system activity and increase parasympathetic nervous system when applied on the paravertebral ganglionar region in hypertensive patients, however, the blood pressure did not change when high frequency TENS applied.

Furthermore, Campos F.V. et al., **[15]** concluded that TENS seems to promote a discrete reduction in SBP, DBP and HR in healthy subjects. Therefore, this results agreed with current study in presence of some difference as our subjects were hypertensive patients.

Also, there were no significant differences in SBP in 3rd, 4th and 6th sessions and no significant differences in DBP in 7th session. This results may be due to any external factors affect patients before, during and after the session.

Conclusion:

The following conclusions were warranted:

The ice application and TENS application had significant effect on improving hypertension but in favor to TENS application.

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تآثير العلاج بالتبريد مقابل التنبيه العصبى الكهربائى على مرضى إرتفاع ضغط الدم

الهدف من الدراسة: هو دراسة تآثير العلاج بالتبريد مقابل التنبيه العصبى الكهربائى على مرضى إرتفاع ضغط الدم.

خطة البحث: آربعون مريضاً تم إختيارهم عشوائياً من مستشفى دسوق العام، دسوق، كفر الشيخ. آعمارهم تتراوح بين ٤٠ إلى ٥٠ سنة. لقد تم تقسيم المرضى إلى مجموعتين متساويتين فى العدد. المجموعة الآولى: تكونت من ٢٠ رجلاً بمتوسط عمر (٤٦±٣.٥) تلقوا العلاج بالتبريد لمدة ٣٠ دقيقة، ٣ مرات إسبوعياً لمدة ٤ آسابيع. المجموعة الثانية: تكونت من ٢٠ رجلاً بمتوسط عمر (٤٧.٨±٢.٧) تلقوا التنبيه العصبى الكهربائى لمدة ٣٠ دقيقة، ٣ مرات إسبوعياً لمدة ٤ آسابيع. لقد تم قياس ضغط الدم قبل وبعد كل جلسة لمدة ١٢ جلسة كنتيجة مباشره ثم قياس ضغط الدم كل إسبوعين ثم بعد ٤ آسابيع كنتيجة على المدى البعيد.

نتائج البحث: يوجد إختلاف واضح فى المجموعتين لكن لصالح المجموعة الثانية.

كنتيجة مباشرة: فى المجموعة الآولى لا يوجد إختلاف واضح فى ضغط الدم الإنقباضى فى ثالث، رابع وسادس جلسة وفى ضغط الدم الإنبساطى فى الجلسة السابعة.

كنتيجة على المدى البعيد: فى المجموعة الآولى لا يوجد إختلاف واضح فى ضغط الدم الإنقباضى لكن يوجد إختلاف واضح فى ضغط الدم الإنبساطى. فى المجموعة الثانية يوجد إختلاف واضح فى ضغط الدم الإنقباضى والإنبساطى.

الخلاصة: العلاج بالتبريد والتنبيه العصبى الكهربائى لهم تآثير فى تحسين الضغط المرتفع ولكن بتآثير واضح للتنبيه العصبى الكهربائى.