Comparative Study between Cryokinetics, Exercises and Cold Application on Nerve Conduction Velocity

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ABSTRACT

The purpose of this study was to investigate the effect of cryokinetics, exercises, and cold application on nerve conduction velocity of the ulnar nerve and their influence on muscle action potential of abductor digiti minimi muscle in healthy subjects. The present study was conduced on the non dominant hand of thirty subjects (21 males and 9 females)aged between 18 and 25 years without any concomitant diseases. They were divided into three groups, the first group received cold application, the second group received hand grip strengthening exercises, and the third group received cryokinetics. Assessment of nerve conduction velocity, proximal latency and distal latency of all subjects were done pre and post treatment. The results showed a significant increase in nerve conduction velocity in the second and third groups while there was a significant decrease in the first group. However, a significant differences was noticable among the three groups in nerve conduction velocity in favor to cryokinetics.

INTRODUCTION

Cryokinetics is a descriptive term refering to the use of cold application followed by immediate exercise program aiming for early recovery and increase in the articular mobility[8].It is a system of inducing analgesia with cooling followed by range of motion exercises[14]. The major goals in the treatment of painful conditions of the musculoskeletal system were restoration of mobility, function, and early return to duty. Cryotherapy, the local application of cold for therapeutic goals, diminishs the inflammatory reaction of trauma, reduces oedema, minimizes haemorrage, decreases pain and produces analgesia if applied immediately after trauma.

These therapeutic effects of cold is achieved via vasoconstriction, decrease in blood flow, reduction in nerve conduction velocity and reducion of muscle spasm[16]. It was reported that low temperature produced prolonged latencies and slower conduction velocity while high temperature produced faster latencies and faster conduction velocity[4,17].

Exercises produce an increase in muscle metabolism which in turn produces an increase in blood flow to the muscle. This increase of blood flow increases nutrients necessary for tissue repair and removes waste products from the injured area. In addition, exercises increase nerve conduction velocity of the muscles, influence the structure and remodelling of collagen and prevent stiffness during the rehabilitation phase[12].

This study provides a guide line for physiotherapists to use cryokinetics in the treatment of sport injuries not only during rehabilitation phase but also during acute one due to the change of neural conduction as well as muscle action potential.

MATERIAL AND METHODS

Subjects

Thirty healthy subjects (21 males and 9 females) with age ranged from 18 to 25 years participated in this study. All subjects were refrained from taking any beverages containing caffeine or smoking, and were not participating in any exercises by the non dominant hand for 6 hours prior the test. The subjects were divided randomly into three groups, each included 10 subjects (7 males and 3 females). The nature of the procedure were explained to all the subjects. The three groups have the same sitting position at arm chair, with the shoulder joint abducted to 60° and elbow flexed to 100°, the non dominant forearm was placed in mid position, rested on a pillow on the chair's arm to prevent any pressure exerted on the ulnar nerve following the technique outlined by Lee et al[15].

First Group

Cryogel ice pack was applied for healthy subjects on the forearm of the non dominant hand above the course of ulnar nerve where it becomes superficial at the medial epicondyle of the humerus (elbow) and above flexor carpi ulnaris muscle for 6 minutes. Heavy towel was wrapped around the packs to keep their temperature.

Second Group

Each subject performed hand strengthening exercises by the non dominant hand for 10 minutes followed by two minutes rest. This process was repeated three times using a hand grip tool with two spiral springs at the first time, four spiral springs at the second time and in the third time six spiral springs.

Third Group

Cryogel ice packs was applied for each subject in the forearm of the non dominant hand as in the first group, then each one performed grip strengthening exercise as the second group.

Assessement was conducted by using conduction velocity, distal conduction latency (it was measured in milliseconds as the interval time between the stimulus artifact and the begining of the action potential) and motor action potential for each subject in each group pre and post application.

a. Electromyography (EMG) apparatus of two channels with surface electrodes was used.
b. Bipolar surface stimulator electrodes were used to stimulate the ulnar nerve.
c. Two surface disc recording electrodes were used to record the motor action potential from the abductor digiti minimi muscle.
d. A metal plate ground electrode was placed on the middle of the forearm to cancel the interference effect of external electrical noise.

Electronic surface thermometer was used to measure the skin temperature pre and post application in the first group, while it was used pre and post and in between application in the second and third groups.

The results had been analyzed statisticaly using paired t- test and ANOVA test. Level of significance was set at 0.05.

RESULTS

The results of the present study were illustrated in table (1) through (3) and fig.(1) and (2). The effect of cold, exercises and cryokinetics on ulnar nerve conduction velocity are pre-sented in table (1) and figure (1) which illu-strate that there was a significant decrease of (NCV) after application of cold while there was a significant decrease of (NCV) after application of exercises and cryokinetics. Comparison between the three groups reveales significant difference at < 0.05 in favor to cryokinetics.

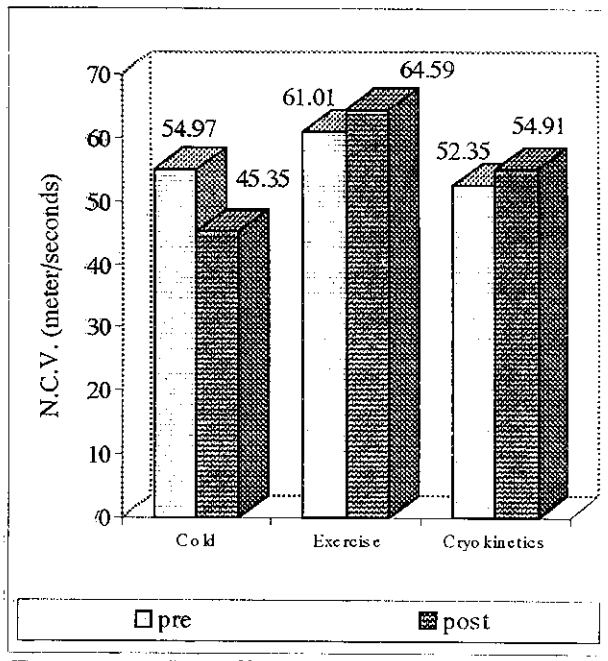

Fig. (1) The effect of cold, exercises and cryokinetics on ulnar NCV.

Table (1) The effect of cold, exercises and cryokinetics on ulnar NCV (meter/second).

	group I		group II		group III	
	Cold		Exercises		Cryokinetics	
	pre	post	pre	post	pre	post
Mean	54.97	45.35	61.01	64.59*	52.35	54.91*
SD	3.70	4.83	6.89	6.76	3.82	2.93
F	35.76					
P	< 0.05*					

* Significant

Effect of cold, exercises and cryokinetics on proximal and distal latencies is presented in table (2) which shows a significant differences between the three groups on proximal latencies while there is a non-significant difference in distal latencies among the three groups.

Table (2) Effect of cold, exercises and cryokinetics on proximal and distal latencies (milli/seconds).

	group I				group II				group III			
	Cold				Exercises				Cryokinetics			
	proximal lat.		distal lat.		proximal lat.		distal lat.		proximal lat.		distal lat.	
	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post
Mean	5.11	6.26	3.44	3.53	5.28	4.97	2.86	2.74	5.24	5.04	2.96	2.75
SD	0.42	0.80	1.25	1.16	0.60	0.51	0.43	0.43	0.57	0.30	0.73	0.66
F	16.12*											
P	< 0.05											

* Significant

Effect of cold, exercises, cryokinetics on skin temperature of ulnar nerve is presented in table (3) and figure (2), which show that there was a significant decrease in skin temperature in group one and three, while there was an increase in skin temperature in group two.

Table (3) The effect of exercises, cold and cryokinetics on skin temperature (centigrade).

	Cold		Exercise		Cryokinetics	
	pre	post	pre	post	pre	post
Mean	27.81	20.72*	27.70	30.21*	27.43	27.41
SD	1.40	0.67	1.24	1.073	1.45	0.86
F	288.16*					
P	< 0.05					

* Significant

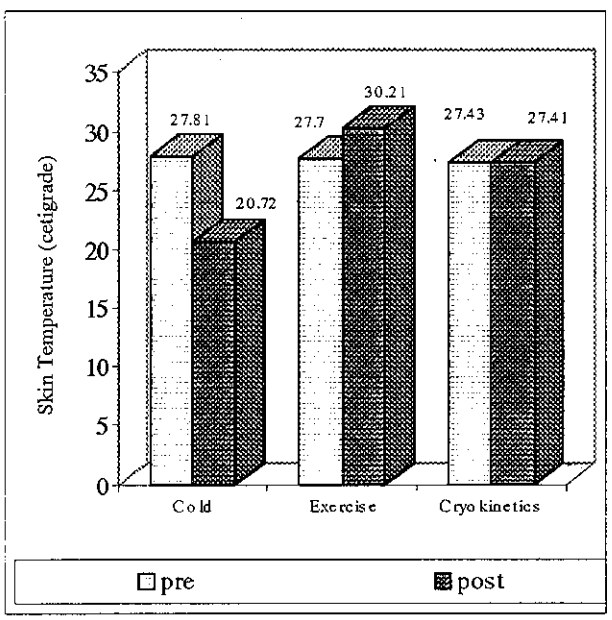

Fig. (2) The effect of exercises, cold and cryokinetics on skin temperature.

DISCUSSION

This study revealed that nerve conduction velocity and skin temperature over the ulnar nerve of the non dominent hand decreased significantly after 6 minutes of ice packs, proximal and distal latency increased non significantly table (1). It was suggested that, the significant decrease of the ulnar (NCV) may be due to change in tissue temperature near the nerve and alternation of membrane permeability. Similar results were obtained by Abramson et al.[2] who reported that motor (NCV) of the median and ulnar nerves were decreased by using ice packs, and these changes in (NCV) are thought to be caused by a fall in tissue temperature. The immediate effect of icing was due to the superficial vasoconstriction which enhances the cooling effect. Following this vasoconstriction a vasodilatation of the superficial blood vessels occurs which, does not affect the continued reduction in motor (NCV). Changes observed during cooling and rewarming were attributed to thermal effects on the nerve fiber membrane[2]. Patients with impaired circulation and hemiplegic patients who had a lower tissue temperature in the affected side might had a reduction of motor (NCV) and abnormal distal latency as compaired to the non affected side. These (NCV) changes correlated significantly with reduction in skin temperature Dejong, et al[6].

In the present study the average decrease of (NCV) of the ulnar nerve was 1.35 m/s./.c°. compared with 2.4 m/sec. a result previously reported by Hendrickson, et al[11]. The present study suggested that the significant increase of proximal latency and the non significant increase of distal latency may be due to decreased skin temperature, decreased blood flow, metabolism and change of membrane permeability. These finding can be explained according Greathouse, et.al[10]. With decreased temperature, the Na^+ permeability of the nerve axons may be decreased during excitation, resulting in slower sodium influx and increased distal latency Hocutt, et al[13].

The present study suggested that the significant decrease of skin temperature after six minutes of icing may be related to the effects produced by direct application of cold to a localized region of the body. Also, Abramson et al. concluded that the skin temperature over the ulnar nerve was reduced rapidly and signifi-cantly after cooling of the forearm to 4 minutes.

The results of the second group in the present study showed that (NCV) and skin temperature increased significantly after ten minutes of exercises interval while proximal and distal latencies were decreased signifi-cantly. It was suggested that the significant increase of ulnar (NCV) may be due to the decrease in tissue temperature near the nerve, alteration of the membrane permeability and improved circulation and metabolism. The present study suggested that, the significant decrease of proximal and distal latencies of the ulnar nerve after exercises may be attributed to the metabolic demands produced by strong exercises, is which there is enough stimulus to increase the metabolic activity, tissue temperature and consequently cause change of conduction latency Hendrickson, et al[11]. Also the physical activities increase tissue metabolic rate, raise tissue temperature and consequently produce increased blood flow. The local nutritional demand and accumulation of metabolic products are usually a determining factors in regulating blood flow through the muscle. These changes would cause alternation of (NCV) . Only one minute of mild exercise produced a sharp increase in metaboalism which was quickly restored to the normal state by a sharp but brief increase in circulation[9].

The results of the present study are supported by the results of many previous studies, who showed that, exercises of 3 to 7 minutes caused a rise of the rate of heat production brought about mostly by the working muscles of the limbs[7].

The results of the third group in the present study also revealed that, ulnar (NCV) was significantly increased after cryokinetics while proximal and distal latencies were decreased, and also there was significant difference of skin temperature near the ulnar nerve. During six minutes of cooling, skin temperature decreased significantly and the rate of cooling was 1.17°c/ min. While during ten minutes of exercising skin temperature increased significantly and the rate of rewarming was 0.69°c/min. Other studies showed that, during ten minutes of icing, cooling occurred at the rate of 2.70°c/min, while warming effect occurred at the rate of 1.9°c/minute, during ten minutes of post treatment rewarming, Bugaj, et al[5].

The present data of the study suggested that the significant increase of ulnar (NCV) after cryokinetics may be attributed to rewarming effect caused by exercises than the cooling effect caused by icing. These results are also supported by previous studies which found that , (NCV) was decreased by cooling to 20°c then increased by increased tissue temperature from 20°c to 36°c, Alfonsi, et al[3].

Also, lower temperatures produced prolonged latencies and slower (NCV) while higher temperatures produced faster latencies and faster (NCV). With decreased temperature Na^+ Permiability of the nerve axon may be less during excitation, resulting in Na^+ influx and increased latency, Kamen, et al[14].

Finally the results of the present study showed that, there was a significant difference among the three groups in (NCV), proximal latency and skin temperature of ulnar nerve and non significant difference in distal latency. Also, in the cryokinetics group, (NCV) of ulnar nerve was increased significantly while

proximal and distal latencies, were decreased, and also there was a significant differences in skin temperature after cryokinetics.So, cryokinetics could be used in the treatment of neuromuscular disorders, sports and recent injuries and as a guide line for the physiotherapists.

Conclusions

Cryokinetics treatment for 16 minutes including 6 minutes of ice pack application followed by ten minutes of strengthening exercise was an effective procedure in increasing the ulnar (NCV) significantly due to the combination effects of ice pack and exercises which cause analgesic effect, improvement circulation and maintainance of free range of motion. So utilization of cryokinetics may help the patients who were suffering from neurological diseases that affect (NCV).

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الملخص العربي

دراسة للمقارنة بين أثر إستخدام دمج (كمادات الثلج ، والتمرينات معا) والتمرينات والثلج على سرعة توصيل الألياف العصبية

الغرض من هذه الدراسة هو مقارنة تأثير استخدام دمج كمادات الثلج والتمرينات معا التمرينات والثلج على سرعة توصيل الألياف العصبية للأشخاص الأصحاء . أجريت هذه الدراسة على ٣٠ شخصا (إناث وذكورا) وتتراوح أعمارهم بين ١٨–٢٥ عاما وقد قسموا عشوائيا الي ثلاث مجموعات متساوية المجموعة الأولى (كمادات الثلج) :– وتضم ١٠ أشخاص وضع لكل فرد كمادات الثلج على الساعد لمدة ٥ دقائق. المجموعة الثانية (التمرينات):– وتضم ١٠ أشخاص وقام كل فرد بممارسة تمارين لتقوية عضلة اليد باستخدام جهاز التقوية لعضلات اليد مزودة باثنين سلك زنبركي في المرة الأولى ثم ٤ أسلاك في المرة الثانية ثم ٦ أسلاك في المرة الثالثة ومدة التمرين دقيقتان تليها راحة لمدة دقيقتان أيضا وذلك لمدة عشرة دقائق. (جـ) المجموعة الثالثة (الكمادات والتمرينات معا) وتضم ١٠ أشخاص يتم وضع كمادات الثلج على الساعد متبعا أسلوب المجموعة الأولى ثم يقوم كل فرد بممارسة التمارين متبعا نفس أسلوب المجموعة الثانية. تم قياس درجة حرارة الجلد وسرعة توصيل الالياف العصبيه قبل وبعد العلاج.

وكانت النتائج ذات دلالة إحصائية عاليه وفرق فعال في جميع التغيرات السابق قياسها بين المجموعات الثلاثة :–

مجموعة الكمادات :– أنخفضت درجة حرارة الجلد وسرعة توصيل الألياف العصبية.

مجموعة التمرينات :– ارتفعت درجة حرارة الجلد وسرعة توصيل الألياف العصبية.

مجموعة دمج الكمادات والتمرينات :– أنخفضت درجة حرارة الجلد وزادت سرعة توصيل الألياف العصبية.

وقد وجد اختلاف بين المجموعات الثلاثة على سرعة توصيل الألياف ودرجة حرارة الجلد.

ولهذا ينصح باستخدام طريقه دمج كمادات الثلج والتمرينات معا في علاج المصابين بأمراض الجهاز العصبى وإصابات الملاعب لماحققه من نتائج فعالة ذات دلالة إحصائية عاليه.