



The Effect Of Duration Of Cryotherapy On Pinch Grip Strength

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Abstract

Background: Cryotherapy has been used for decades as to attain specific therapeutic objectives and pinch grip activities are very common in our day to day life. The aim of the study was to find how long the effect of cryotherapy withstands on pinch grip strength.

Objective: The purpose of the study was to find the duration of the effect of cryotherapy on pinch strength.

Methods: Participants of age group between 18 to 26 years were recruited. Prior to the experiment skin temperature and pinch grip strength was measured. Subjects were asked to immerse their hand in 10°C of cold water for fifteen minutes. Post cryotherapy, Pinch strength along with the measurement of skin surface temperature was assessed immediately after immersion and at 5, 10, 15minutes.

Result: Paired T-test was used to compare the parameters and Pearson's Correlation was used to correlate between parameters. A statistically significant positive correlation was noted between the pinch strength and the skin temperature of thenar eminence, thumb and index finger. This indicates that the decrease in skin temperature resulted in decrease in pinch strength.

Conclusion: The skin temperature decreased immediately after the application of cryotherapy which resulted in decrease of pinch strength and was reverted back to normal by 15 minutes.

Keywords: Cryotherapy, Pinch strength, Skin temperature

Introduction

Cryotherapy is widely used to relieve muscle pain, strain and swelling including soft tissue damage and post operative swelling. The initial response of the body to cold is to preserve the heat, which is attained by initial response of vasoconstriction. When homeostasis is reached there comes a phase of vasodilation followed by alternate phases of vasoconstriction and vasodilation. In addition to its effect on relieving pain, cryotherapy also carries away chemical substances which are stimulating muscle tone by its increased circulation. The short brisk application of cold is thought to enhance the muscle tone; while prolonged use of cold reduces the muscle tone to a greater extent. Cryotherapy has been

shown to diminish muscular power and function which together with inadequate proprioception could impair the motor control of the joint, causing increased risk of injury. ^[1, 2] Application of cold can reduce the rate of conduction in a nerve. Conduction in both afferent and efferent is reduced linearly with the decrease in temperature. This along with decreased proprioception and muscle function can result in decreased manual dexterity including muscle strength with application of cold. ^[3]

Gripping and pinching activities are very common in daily life or in various work places. Pinch strength is considered in a checklist for evaluation of Cumulative Trauma Disorder^[4] which is strongly associated with workplace injuries who are exposed

to extreme cold environments which can affect their task performances. These tasks can typically include typing, writing, grasping objects, using tools etc.^[5] Johnson et al. found that there was a decrease in grip strength after prolonged cold water immersion,^[4] so that the people need to apply higher pinch grip forces under cold temperature in order to feel that they are handling the work safely.^[6] Pinch grip strength can be quantified by using Pinch gauge hydraulic dynamometer, asking subject to maximally press the bar of pinch strength dynamometer between the thumb and index finger.^[1]

Various studies are done to find the effect of cryotherapy on pinch grip strength and other parameters. There are studies on effect of cryotherapy on sensation and pinch strength and it proved that application of cold diminishes the pinch grip strength.^[1] But there is no study done on the duration of recovery after cryotherapy application on pinch grip strength. Thus, this study was done to find how long the effect of cryotherapy withstands on pinch grip strength.

Material and Methods

This experimental study was done among 42 participants. They were screened for the inclusion and the exclusion criteria and those fulfilling the criteria were included in the study. Participants were explained about the study and an informed consent was taken. Ethical clearance was approved by the Institutional ethical committee. The inclusion criteria kept in this study were Healthy Individuals (self reported healthy, non smokers and not on any medication), both male and female aged between 18 to 26 years. Participants with Upper limb dysfunction, any neurological or musculoskeletal disorders, history of any cold allergy, or frost bite were excluded from the study. Participants were asked to sit on a chair in a relaxed position. Skin temperature was checked by using Non-Contact Infrared Thermometer (NCIT) and pinch grip strength was measured using a pinch gauge hydraulic dynamometer. Participants were asked to maximally press the bars of the pinch strength dynamometer between the thumb and index finger for 10 seconds; it was repeated 3 times, with 1 minute rest between each trial. Then the participants were asked to immerse their hand into the ice bath having a

temperature of 10°C at the beginning of testing for 15 minutes. Temperature of ice water was checked with mercury thermometer and was allowed to warm as it would be in a practical setting in the normal room. After treatment, participants dried their hands with towel and temperature of water was measured in order to adjust for the next treatment. The temperature and pinch strength were reassessed immediately after immersion and at 5, 10, 15 minutes of hand exposure to recovery phase. The entire process was completed on the dominant hand.

Statistical Analysis

Quantitative variables were reported using mean and standard deviation. Qualitative variables were reported using frequency and percentage. Paired T-test was used to compare the parameters and Pearson's Correlation was used to correlate between parameters by using SPSS version 17. $P < 0.05$ was considered as statistically significant.

Results

The skin temperature decreased immediately after the application of cryotherapy and later it was increasing and was almost same as that of the pre-experiment temperature after 15 minutes of cold water immersion. When compared between the pre and post skin temperature on thenar eminence, the result showed a statistical significant difference post experiment immediately, 5 minutes later, 10 minutes later and at 15 minutes (Table 2). Similarly when compared between the pre and post skin temperature on thumb also, statistical significant difference was observed at immediate application, 5 minutes, 10 minutes and 15 minutes of cold therapy (Table 3). When compared at index finger as well, a statistical significant difference was observed at all the time intervals after cold therapy application when compared between pre and post skin temperature. (Table 4)

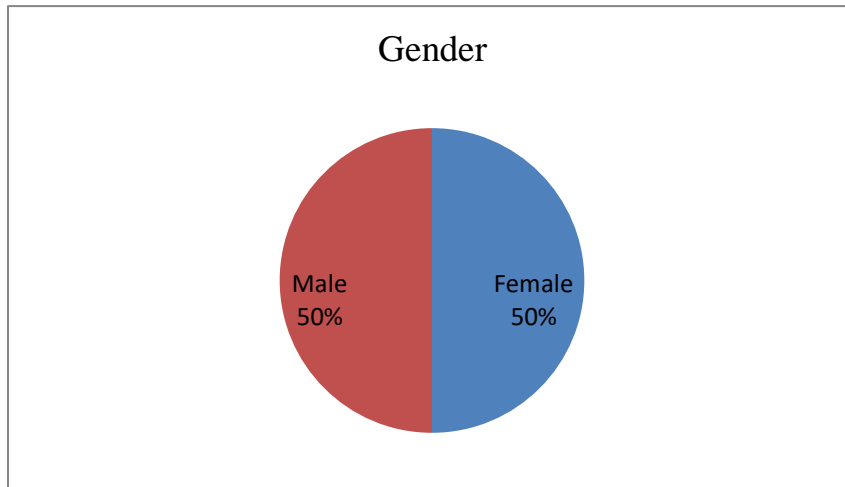
There was a statistically significant reduction in grip strength immediately after cryotherapy application as well as at 5 minutes and 10 minutes. However there was no statistically significant difference between the grip strength of baseline and at 15 minutes, i.e. it reached close to the pre-experiment strength (Table 5).

A statistically significant positive correlation was noted between the pinch strength and the skin temperature of thenar eminence, thumb and index finger (Table 6).

Table 1. Descriptive details of age.

	N	Mean	SD
Age	42	20.98	2.02

Graph 1. Gender distribution among the study population



Graph 2. Hand dominance distribution among the study population

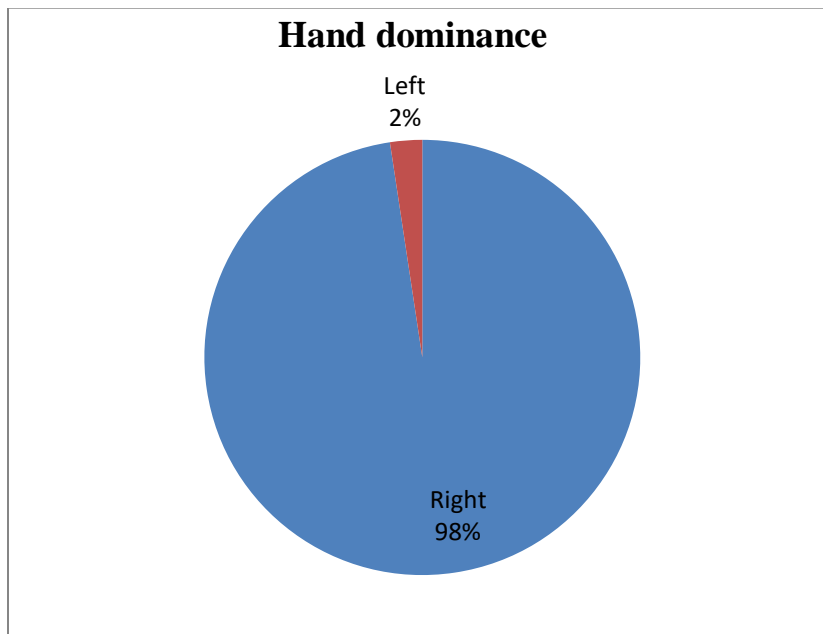


Table 2. Comparison of Pre and Post skin temperature measured in degree Celsius on thenar eminence at different intervals

Variables	Mean	N	SD	P-value

PTE	34.04	42	2.32	0.000
TEPI	25.21	42	2.81	
PTE	34.04	42	2.32	0.000
TEP5	28.81	42	2.16	
PTE	34.04	42	2.32	0.000
TEP10	30.70	42	1.60	
PTE	34.04	42	2.32	0.000
TEP15	31.72	42	1.55	
PTE- Pre-experiment Thenar Eminence, TEPI – Post-experiment Thenar Eminence Immediate, TEP5 - Post-experiment Thenar Eminence at 5 minutes, TEP10 - Post-experiment Thenar Eminence at 10 minutes, TEP15 - Post-experiment Thenar Eminence at 15 minutes				

Table 3. Comparison of Pre and Post skin temperature measured in degree Celsius on Thumb at different intervals

Variables	Mean	N	SD	P-value
PT	31.64	42	3.58	0.000
TPI	26.91	42	1.96	
PT	31.64	42	3.58	0.000
TP5	28.64	42	1.81	
PT	31.64	42	3.58	0.001
TP10	29.37	42	1.32	
PT	31.64	42	3.58	0.002
TP15	29.72	42	1.49	
PT-Pre-experiment Thumb, TPI- Post experiment Thumb Immediate, TP5- Post experiment Thumb at 5minutes, TP10- Post experiment Thumb at 10minutes, TP15- Post experiment Thumb at 15minutes.				

Table 4. Comparison of Pre and Post skin temperature measured in degree Celsius on Index finger at different intervals

Variables	Mean	N	SD	P-value
PI	31.93	42	3.39	0.000
IPI	26.48	42	3.80	
PI	31.93	42	3.39	0.000
IP5	28.21	42	3.89	
PI	31.93	42	3.39	0.000

IP10	28.88	42	3.74	0.000
PI	31.93	42	3.39	
IP15	29.15	42	3.80	
PI-Pre-experiment Index, IPI- Post-experiment Index Immediate, IP5- Post-experiment Index at 5minutes, IP10- Post-experiment Index at 10minutes, IP15- Post-experiment Index at 15minutes.				

Table 5. Comparison of Pre and Post Pinch Strength measured in kilograms at different intervals

Variables	Mean	N	SD	P-value
PPS	7.50	42	1.71	0.000
PSPI	6.46	42	1.86	
PPS	7.50	42	1.71	0.000
PSP5	6.83	42	1.89	
PPS	7.50	42	1.71	0.001
PSP10	7.08	42	1.81	
PPS	7.50	42	1.71	0.201
PSP15	7.35	42	1.78	
PPS-Pre-experiment Pinch Strength, PSPI-Post-experiment Pinch Strength Immediate, PSP5-Post-experiment Pinch Strength at 5minutes, PSP10-Post-experiment Pinch Strength at 10minutes, PSP15-Post-experiment Pinch Strength at 15minutes				

Table 6. Correlations of Pinch strength with skin temperature of Thenar Eminence Thumb and Index finger.

		Temp. Thenar Eminence	Temp. Thumb	Temp. Index finger
Pinch Strength	Pearson Correlation	0.985	0.956	0.919
	P value	0.002	0.011	0.028

Discussion

The purpose of the present study was to find the acute effect of cryotherapy on pinch grip strength among the healthy individuals and to find how long the effect of cryotherapy persists. Mean age of the study was 21 years (Table 1). The study was done among 42 healthy individuals with 21 female and 21 male. In the present experiment most (97.6%) of the individuals were right hand dominant (Graph 1 and 2).

The pre and post experiment skin temperature was measured on thenar eminence, thumb and index finger using NCIT. Post experiment skin temperature was measured at different intervals (Immediately, at 5, at 10 and at 15 minutes). There was a decrease in the skin temperature immediately after 15 minutes of cryotherapy application. The baseline temperature of thenar eminence was 31.65⁰C and post cryotherapy temperature of thenar eminence at immediately, 5minutes, 10minutes, and 15minutes was 25.21⁰C,

28.81⁰C, 30.70⁰C, & 31.72⁰C respectively. The skin temperature tested on the thenar eminence showed significant difference when compared with baseline skin temperature. The p value was 0.000 at immediately, 5, 10 and 15 minutes of post cryotherapy application (Table 2). Our results are in accordance with a study done by Sunitha J in (2010) who reported that cryotherapy reduced skin temperature by 10⁰C to 15⁰C within 15 minutes.^[7]

The baseline value for thumb (31.64⁰C) when compared with post experiment value at Immediate, 5, 10 & 15 minutes showed a significant difference (p value: 0.00, 0.00, 0.001, 0.002). Similarly the pre-experiment skin temperature of index finger (31.93⁰C) showed statistically significant difference when compared with the post-experiment skin temperature at Immediate, 5, 10 & 15 minutes (P value 0.00)

Cataldi J K et al, reported that ice massage and cold water immersion produced numbness significantly faster than the crushed ice. Changes in cutaneous sensation can be achieved in a relatively short amount of time (6-12 minutes) with ice massage and ice water immersion.^[8]

The pinch strength was studied immediately following the cryotherapy and demonstrated significant reduction in strength. It was measured for pre and post experiment at different intervals (Immediately, 5, 10 and 15 minutes). The mean baseline value of pinch strength was 7.50kg and there was a statistically significant reduction in grip strength immediately after cryotherapy application as well as at 5 minutes and 10 minutes. Bhandari B et al. reported that the cryotherapy showed significant reduction in pinch strength immediately after application of cryotherapy.¹Mattacola C G. et al, reported that isokinetic plantar flexor strength reduced immediately after cold water submersion.^[9] However there was no statistically significant difference between the grip strength of baseline and at 15 minutes, i.e. it reached close to the pre-experiment strength (Table 5).

In our study the participants were asked to immerse their hand into the ice bath having a temperature of 10⁰C at the beginning of testing for 15 minutes. Various studies noted that immersion of forearm in cold water at 10⁰C for 30 minutes significantly decreased the grip strength.^[10, 11] Douglas M et al.

suggested that cryotherapy to ankle had a negative effect on the Medio-Lateral component of dynamic balance following ice water immersion. Immediate return to play following cryotherapy application is cautioned due to the decreased dynamic Medio-Lateral balance and potential for increase injury risk.^[12]

A statistically significant positive correlation was noted between the pinch strength and the skin temperature of thenar eminence, thumb and index finger. (Table 6) This indicates that the decrease in skin temperature resulted in decrease in pinch strength, which is in par with the previous studies. However there was no attempt made by previous researchers to know how long the effect of cryotherapy lasted. The present study was able to document that the pinch strength was back to normal by the 15minutes of post cryotherapy. Therapist can take this finding into consideration while using cryotherapy as a part of hand rehabilitation. The patient should be advised not to do any manipulative function for 15minutes post cryotherapy which requires grip strength in order to prevent any adverse effect. Further studies require a larger sample size and inclusion of patients in rehabilitation centre so that the results would be more generalizable for clinical implication.

Conclusion

The skin temperature decreased immediately after the application of cryotherapy which resulted in decrease of pinch strength and was reverted back to normal by 15 minutes. This finding should be considered by the therapist when giving cryotherapy to hand as part of rehabilitation.

References

1. Bhandari B, Parmar L. Effects of cryotherapy on sensation and pinch strength. Journal of Integrated Health Sciences. 2013 Jul 1;1(2):76.
2. Oliveira R, Ribeiro F, Oliveira J. Cryotherapy impairs knee joint position sense. International journal of sports medicine. 2010 Mar;31(03):198-201.
3. Rubley MD, Denegar CR, Buckley WE, Newell KM. Cryotherapy, sensation, and isometric-force variability. Journal of athletic training. 2003 Apr;38(2):113.

4. Shih YC, Chen WL, Chi CF. The Effects of Gender, Exerting type, and Temperature on Hand grip/pinch strength under the Muscular Fatigue. Women. 2009 Aug 20;29(24.0):240.
5. Theiss CL. The Effects of Cold Ambient Temperature on Maximal Isometric Handgrip and Pinch Strength in Healthy Men and Women (Doctoral dissertation, Indiana State University).
6. Johnson DJ, Leider FE. Influence of cold bath on maximum handgrip strength. Perceptual and motor skills. 1977 Feb;44(1):323-6
7. Sunitha J. Cryotherapy–A review. J ClinDiagn Res. 2010 Apr;4(2):2325-9.
8. Cataldi JK, Pritchard KA, Hart JM, Saliba SA. Cryotherapy effects, part 2: Time to numbness onset and numbness duration. International Journal of Athletic Therapy and Training. 2013 Sep; 18(5):26-8.
9. Mattacola CG, Perrin DH. Effects of cold water application on isokinetic strength of the plantar flexors. Isokinetics and Exercise Science. 1993 Jan 1; 3(3):152-4.
10. Johnson DJ, Leider FE. Influence of cold bath on maximum handgrip strength. Perceptual and motor skills. 1977 Feb; 44(1):323-6.
11. Coppin EG, Livingstone SD, Kuehn LA. Effects on handgrip strength due to arm immersion in a 10 degree C water bath. Aviation, space, and environmental medicine. 1978 Nov; 49(11):1322-6.
12. Douglas M, Bivens S, Pesterfield J, Clemson N, Castle W, Sole G, Wassinger CA. Immediate effects of cryotherapy on static and dynamic balance. International journal of sports physical therapy. 2013 Feb; 8(1):9.