ORIGINAL ARTICLE

IJPHY

IMMEDIATE AND LATE EFFECT OF CRYOTHERAPY ON BALANCE IN HEALTHY SUBJECTS

*[1]Yomna F.Ahmed
[2]Neveen A. Abdel Raoof
[3]Mohsen M. EL-Sayyad
[4]Doaa I. Amin

ABSTRACT

Background: cryotherapy application is commonly used as a physical therapy tools with many advantages, however numerous researchers have stated decrease in subject balance which affects quality of movement following cryotherapy application, thus the purpose of study was to investigate the immediate and late effect of cryotherapy on ankle dominant joint on static balance and test the difference in static balance change between both sexes.

Methods: Thirty healthy subjects, Subjects had their static balance tested during two conditions: (1) an experimental condition where the subject received the cryotherapy application by using cooled gel pack to the dominant ankle joint for 15 minutes immediately before static balance testing and (2) a control condition finished at room temperature. Using coin flip for randomization the order of examining condition. Biodex balance system was used to measure static balance.

Results: analysis of data using ANOVA and unpaired test, show insignificantly statistically effect in all aspect of static balance within female group and within male group with p-value of overall stability index for female=0.669, for male =0.382, Anterior/posterior stability index for female =0.196, for male=0.552 and medial/lateral stability index for female =0.989, for male=0.46 and insignificant statistically difference between male and female in all aspect of static balance.

Conclusion: the result of the study suggest that using cold gel pack for fifteen minutes of cold gel pack on dominant ankle extremity have no effect on static balance on both sexes.

Keywords: Static balance, Cryotherapy.

Received 20th December 2016, revised 13th February 2017, accepted 25th March 2017

10.15621/ijphy/2017/v4i2/141945

www.ijphy.org

[2]professor and chairman of physical therapy for basic science,Cairo university.
Working address: 7 Ahmed El Zayyat Street, Dokki, Giza.
[3]Professor of physical therapy for basic science,Cairo university. F. Dean faculty of physical therapy, Modern university, 7Ahmed El Zayyat Street, Dokki, Giza.
[4]Lecturer of Physical Therapy for Basic Science, Cairo University. 7 Ahmed El Zayyat Street, Dokki, Giza.

CORRESPONDING AUTHOR

***[1]Yomna Farag Ahmed**

Head of Physical Therapy Department, Railway Hospital, Cairo.

This article is licensed under a Creative Commons Attribution-Non Commercial 4.0 International License.

INTRODUCTION

Cryotherapy therapy is an popular non-pharmacological intervention, The expression "cryotherapy" was utilized in the year 1908 by A.W. Pusey to portray skin injuries treatment with reduced temperatures[1,2], The primary aim of cryotherapy is the removal of heat energy from the site of injury, in order to facilitate a therapeutic effect [3] by produces a number of physiological effects on the human body including a reduction in blood flow, edema, hemorrhage[4], cellular metabolic rate, hypoxia, enzymatic activity and tissue damage[5]. Cryotherapy has also been demonstrated to significantly increase the pain threshold and pain tolerance by reducing nerve conduction velocity and muscle spasm [6].

Cryotherapy often used in athletic and rehabilitation cases to manage injury during the immediate and rehabilitative phases [7]. Cryotherapy treats the muscle damage caused by High-intensity exercise including predominantly eccentric activity, unaccustomed activity, and exercise of long duration and high intensity which has been shown to induce an inflammatory response [8].

In spite of the characterized treatment advantage of cryotherapy, there is a reduction in subjects execution factors are probably going to occur after coming back to normal movement quickly after cryotherapy application, [9] especially, decrease the speed of running, muscle strength rapidity and nimbleness over many anatomical areas.[10,11].

The ability to conserve postural control or balance is critical for the right way of carrying out daily activity extends from standing and walking to sitting and standing from a seat [12] Having the capacity to conserve several positions, for automatic reaction to voluntary body movements, and outside disturbance represents a postural control needed for activity of daily living [13].

The maintenance of balance is essential in the prevention of injuries, and this ability relies on upon proprioceptive contribution from capsuloligamentous and musculotendinous mechanoreceptors in combining with a vestibular and visual input to the central nervous system (CNS) [14,15]. This information utilized in feedback and feed-forward loops to give the proper neuromuscular reaction [16-17]. Variations in any of this information would disturb the balance and increase the risk of injury [18].

There is also growing awareness that rehabilitation using cryotherapy has deleterious effects on balance, or return patients to their previous functional levels [19, 20]. The quality of movement is important as the strength of motion, and the key to movement quality is a balance [21]. Even if a patient has regained full strength and range of the movement, if they still have poor balance and proprioception, they are at risk of re-injury.

During the management of acute distortion, cryotherapy is commended after the injury, and in rehabilitation, ice application is supposed to promote the beginning of the active exercise and its progression [7]. In practice, it can happen that athletes are sent back to exercising or competition immediately after cryotherapy. Although the question is controversially discussed if physical activities after ice application can be re-established without risk or increase liability to injury. This study takes up the problems if cryotherapy application at the ankle disrupts static balance so that a higher risk of injury: could result and the study also clarify the immediate and late effect and test the difference in static balance between both sexes.

METHODOLOGY

The current study was conducted at biomechanics laboratory at physical therapy faculty, modern university, in December 2015 to April 2016 to investigate the immediate and late effect of cryotherapy application on dominant ankle joint on static standing balance and test the difference in static balance between both sexes.

Design of study

Crossover (single repeated measurements) design used in the study for determining the immediate and late effect of cryotherapy application on dominant ankle joint on static standing balance and test the difference in the static standing balance between both sexes.

Subjects

A sample of thirty healthy normal subjects (fifteen male and fifteen female), subjects were recruited using publically distributed posters and by online social media. Subjects their static balance examined through two situations: (1) an experimental situation, the subject got the cryotherapy application by using cooled gel pack to the dominant ankle joint for fifteen minutes immediately before testing static balance and (2) a control situation finished at room temperature. Using a coin flip for randomizing the order of examining the situation. Participant completed the control situation first immediately ended the experimental situation following assessment. Participants randomized to the cryotherapy situation first had the control session arranged at a separate time to confirm no lingering effects remain from the cryotherapy procedures.

Subjects participated in the current study after the endorsement of the ethical committee of the faculty of physical therapy, Cairo University with number P.T.REC/012/001035 and subjects provided informed consent. Subjects were included if their age range from 18 to 40 years [22] free from musculoskeletal diseases and neurological disorders affecting the lower limb. Excluded if had musculoskeletal disorders in the lower limb, had infected skin diseases and loss of sensation, had a Metabolic or vascular disease with a neurological component such as diabetes, had previous ankle operation and had a recent injury to ankle joint.

Instrumentation

1) Measurement instrumentation

The device used in this study (Biodex Medical Systems Inc., Shirley, New York, USA) was a foot platform (circular in shape with a diameter of 21.5′, which permits up to 20° tilting in all direction from horizontal), support rails that were adjustable from 25′ to 36.5′ above the platform, and could

be swung away if desired, a display module whose height was adjustable from 53′ to 68′ above the platform and angle was adjustable from vertical back to 45°, with a screen viewing area of 24.8 × 18.4 cm and a printer. This testing machine had 12 dynamic levels plus locked for static measurements [23].

Stability Indexes

The stability index represents the variance of platform displacement in degrees from level. An increase in number indicates considerable motion, which indicates a problem with balance [24]. The participant's ability to control the platform's angle of tilt was measured by the system and noted as a stability index. The data on the balance of the tested participants were supplied to the system. These data included anteroposterior stability index (APSI), mediolateral stability index (MLSI), and overall stability index (OSI). The smaller the amount of sway, the lower the numerical value of these indexes [24].

2) Therapeutic instrumentation:

Reusable cold gel packs 25.4 x 48.1 cm. 5 +/- degree C [25] was frozen and wrapped in a towel and supported with an elastic strap around the ankle joint of dominant lower extremity.

PROCEDURE

Each participant received a verbal explanation of the test steps. When the system was on, the first displayed screen was the main menu. It allowed us to choose entering testing, training, or system utilities. Choosing to enter testing showed the next screen, which allowed determination of the test parameters such as test duration and the stability level selected. The weight and height of the participant were recorded, and the next screen was used for the centering process. The next screen was the stability test screen, where the start key was pressed to lock or unlock the platform and begin the test. A cursor appeared during the trial tracing the movement of the platform while the clock counted till the time of the trial ends. The next screen showed a menu. The examiner chooses the numeric report option on this screen to allow the participant's digital screen appear. Pressing start while on this screen initiates printing of the report, which includes the numeric values of the APSI, MLSI, and OSI (operation and service manual).

Step 1: Balance Assessment

The participants were tested without footwear and asked to perform two test trials before a specific test condition for the purpose of instrument familiarity before data collection. Then, the participant was first asked to assume the test position (standing on dominant foot) with arms held at the sides, eye closed and to attempt to control his/her balance as much as possible. Each participant was asked to center him/herself on the foot platform before starting the test.

The test parameters introduced into the device were:

1. Participant's age, weight, and height
2. The level of stability: participants were tested on 0 level of stability for 15 s.

Then, the start key was pressed in the control panel (which took 5 s) with an auditory alarm just before the beginning of the test. The participant was instructed that the test was started just after the alarm. Each participant was instructed to maintain his/her balance for the period of the test. Three trials were performed before the measurement.

There was report gained after finishing every test includes information on MLSI, OSI, and APSI.

Step 2: cryotherapy application

Reusable cold gel packs 25.4 x 48.1 cm. 5 +/- degree C used as the cryotherapy modality in this study. Duration of the application was 15 minutes. Wrapping of a pack by towel was applied all around the ankle joint of domain extremity with a towel in between. Two elastic straps used for fixation the ice pack. The subject was requested to be relaxed through the application of cryotherapy to minimize the activity of muscle and lessen alteration in tissue temperature.

Step 3: balance reassessment

The participant was asked to repeat the same balance testing procedures directly after cryotherapy application, 30 minutes later and 60 minutes later to measure post-OSI, MLSI, and APSI.

Statistical analysis

Statistical analysis was carried out by using SPSS, version 23 for Windows; SPSS Inc., Chicago, Illinois, USA. Descriptive data for participants, characteristics was calculated as "the mean, standard deviation, and range "minimum & maximum" of measured variables, ANOVA tests used to compare between pretest and posttest. A unpaired test used to compare between male and female. The level of significant will set at <0.05.

RESULTS

General characteristics of the subjects:

In this study, thirty subjects were assigned randomly, the range of the ages is between 18 to 40 years old, the range of the weight is between 50 to 105 kg, and the range of the Height is between 156 to 195 cm. There was no statistically significant difference between the groups in their ages, weight and height as the p-value for age are 0.412, for weight are 0.214 and for height are 0.366.

Table 1: Demographics Distribution

Items	Male	Female	Comparison		Significant
	Mean±SD		T-value	P-value	
Age (years)	26.4 ± 6.08	25.533 ± 5.41	0.412	0.682	No Significant
Weight (Kg)	70.89 ± 14.57	77.2 ± 5.41	-1.270	0.214	No Significant
Height (cm)	165.27 ± 4.57	166.66 ± 6.41	-0.411	0.366	No Significant

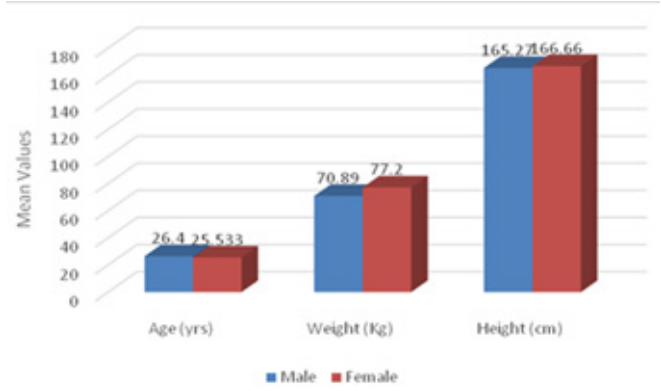

Figure 1: Demographics Distribution

As for the gender distribution, 15 subjects (50%) were male, and 15 subjects (50%) were females. Also, 26 subjects (86.7%) had their dominant right leg tested, and four subjects (13.3%) had their dominant left leg tested.

Static Balance

A) Pre-test

The results are shown using the following table (2) and illustrated in figure (2).

1) Overall Stability Index

Independent t-test was used to show a difference between pretest for females and males. The female, mean value of overall stability index (3.47±1.42) was significantly different from (5.04±2.31) with t-test = -2.242 and p-value = 0.033*.

2) A/P Stability Index

Independent t-test was used to show a difference between pretest for females and males. The female mean value of A/P Stability index (2.41 ± 0.85) was significantly different from (3.393±1.65) with t-test = -2.157 and p-value = 0.043.

3) M/L Stability Index

Independent t-test was used to show a difference between pretest for females and males. The female mean value of M/L Stability index (2.01 ± 1.08) was insignificantly different from (2.99±1.72) with t-test = -1.887 and p-value = 0.072.

Table 2: The pre-test results for the Stability Indices - Static

Stability Index	OSI	APSI	MLSI
Pre-test for Females	3.67±1.41	2.407±0.85	2.01±1.08
Pre-test for Males	5.04±2.3	3.39±1.65	2.99±1.72
Independent t-value p-value	-2.492 0.033* Significant	-2.157 0.045* Significant	-1.884 0.072 Insignificant

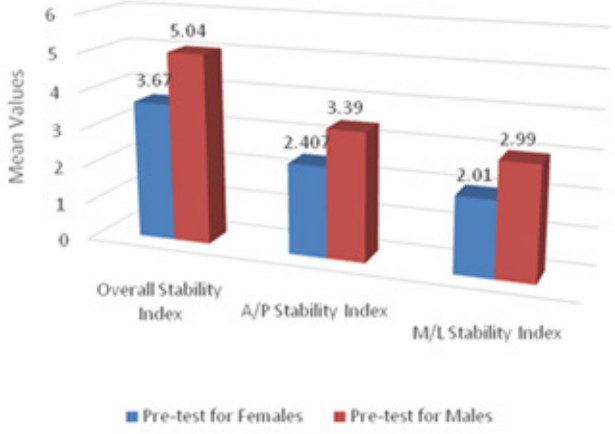

Figure 2: The pre-test results for the Stability Indices - Static

B) Within Group (Females)

The results are shown using the following table (3) and illustrated in figure (3). ANOVA F-test was used to show a difference between pre and post-test in the stability indices.

1) Overall Stability Index:

The mean value was pretest (3.47±1.42) when compared with its corresponding no significant difference after assessment immediately (3.78±1.868), after 30 minutes (3.41 ± 2.27), and after 60 minutes (4.29 ± 2.86) with f test = 0.521 and p-value = 0.66.

2) A/P Stability Index:

The mean value was pretest (2.41 ± 0.85) when compared with its corresponding no significant difference after assessment immediately (2.47 ± 1.52), after 30 minutes (2.14 ± 1.27), and after 60 minutes (3.27 ± 1.43) with f test = 1.616 and p-value = 0.196.

3) M/L Stability Index:

The mean value was pretest (2.01 ± 1.08) when compared with its corresponding no significant difference after assessment immediately (2.2 ± 1.07), after 30 minutes (2.12 ± 1.84), and after 60 minutes (2.13 ± 1.98) with f test = 0.04 and p-value = 0.989.

Table 3: The mean values and S.D of Stability Indices before starting and after the test for Females - Static

Data of evaluations	OSI	APSI	MLSI
Pre-test	3.47 ± 1.42	2.41 ±0.85	2.01± 1.08
Post-Immediate	3.73 ± 1.868	2.47± 1.52	2.2± 1.07
Post-30 minutes	3.41 ± 2.27	2.14±1.27	2.12± 1.84
Post-60 minutes	4.29 ± 2.86	3.27± 1.43	2.13± 1.98
F-value ANOVA	0.521	1.616	0.04
p value	0.669 Insignificant Difference	0.196 Insignificant Difference	0.989 Insignificant Difference

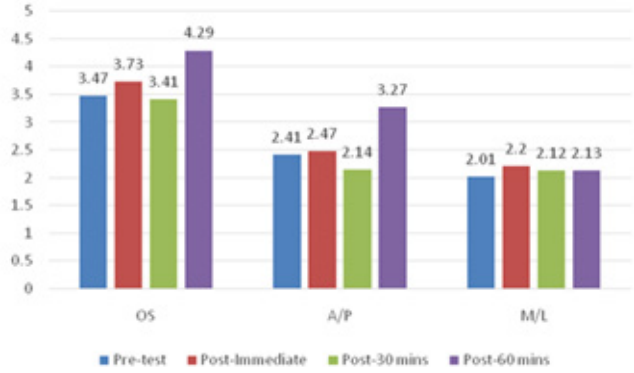

Figure 3: Mean values and S.D of Stability Indices before starting and after the test for Females - Static

C) Within groups (Males)

The results are shown using the following table (4) and illustrated in figure (4). ANOVA F-test was used to demonstrate the difference between post-test in the stability indices.

1) Overall Stability Index:

The mean value was pretest (5.04±2.3) when compared with its corresponding no significant difference after assessment immediately (5.01± 1.765), after 30 minutes (4.42±2.22), and after 60 minutes (3.95±1.56) with f test = 1.039and p-value = 0.382.

2) A/P Stability Index:

The mean value was pretest (3.39±1.69) when compared with its corresponding no significant difference after assessment immediately (3.4±1.42), after 30 minutes (3.11± 1.78), and after 60 minutes (2.67± 1.416) with f test = 0.707and p-value = 0.525.

3) M/L Stability Index:

The mean value was pretest (2.99± 1.72) when compared with its corresponding no significant difference after assessment immediately (3.02±1.28), after 30 minutes (2.52± 1.55), and after 60 minutes (2.33± 1.02) with f test = 0.874and p-value = 0.46.

Table 4: The mean values and S.D of Stability Indices before starting and after the test for Males - Static

Data of evaluations	OSI	APSI	MLSI
Pre-test	5.04±2.31	3.39±1.65	2.99± 1.72
Post-Immediate	5.01± 1.765	3.4± 1.42	3.02± 1.28
Post-30 minutes	4.42± 2.229	3.11± 1.78	2.52± 1.55
Post-60 minutes	3.95±1.56	2.67± 1.42	2.33± 1.02
F-value ANOVA	1.039	0.707	0.874
p value	0.382 Insignificant Difference	0.552 Insignificant Difference	0.46 Insignificant Difference

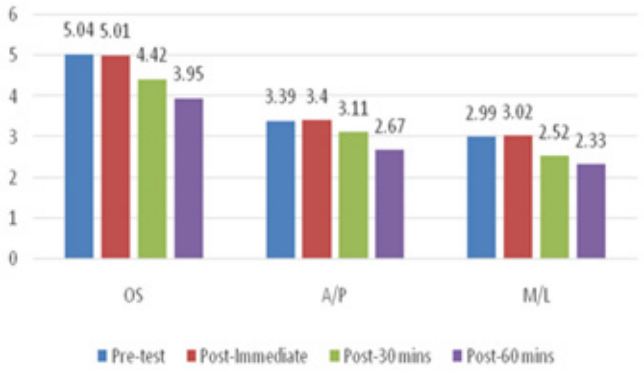

Figure 4: Mean values and S.D of Stability Indices before starting and after the test for Males - Static

D) Post-test results - Static

The results are shown using the following table (5) and illustrated in figure (5). Independent t-test was used to show the difference between post-test in the stability indices.

1) Overall Stability Index

Independent t-test was used to show a difference between immediately post-test for females and males. The female mean value of overall stability index (3.73 ± 1.868) was insignificantly different from (5.01 ± 1.765) with t-test = -1.913and p-value = 0.063.

Independent t-test was used to show a difference between 30 minutes post-test for females and males. The female mean value of overall stability index (3.41 ± 2.27) was insignificantly different from (4.42 ± 2.229) with t-test = -1.227and p-value = 0.23.

Independent t-test was used to show the difference between 60 minutes post-test for females and males. The female mean value of overall stability index (4.29 ± 2.86) was insignificantly different from (3.95 ± 1.56) with t-test = 0.415 and p-value = 0.682.

Table 5.a: The mean values and S.D of Overall Stability Index post-test for both Females and Males-Static

	Stability Index	Immediate	30 Minutes	60 Minutes
Overall Stability Index	Post-test for Females	3.73 ± 1.868	3.41 ± 2.27	4.29 ± 2.86
	Post-test for Males	5.01 ± 1.765	4.42 ± 2.229	3.95 ± 1.56
	Independent t-value p value	-1.913 0.063 Insignificant	-1.227 0.23 Insignificant	0.415 0.682 Insignificant

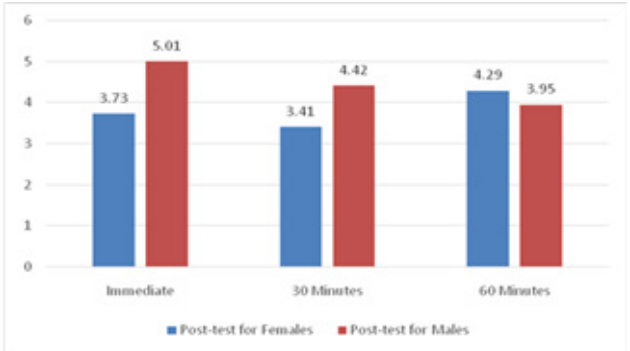

Figure 5.a: The mean values and S.D of Overall Stability Index post-test for both Females and Males-Static

2) A/P Stability Index

Independent t-test was used to show a difference between immediate post-test for females and males. The female mean value of A/P Stability index (2.47 ± 1.52) was insignificantly different from (3.4 ± 1.42) with t-test = -1.699and p-value = 0.1.

Independent t-test was used to show a difference between 30 minutes post-test for females and males. The female mean value of A/P stability index (2.14 ±1.27) was insignificantly different from (3.11 ± 1.78) with t-test = -1.723and p-value = 0.096.

Independent t-test was used to show a difference between 60 Minutes post-test for females and males. The female mean value of A/P stability index (3.27 ± 1.43) was insignificantly different from (2.67 ± 1.42) with t-test = -0.925 and p-value = 0.363.

Table 5.b: The mean values and S.D of A/P Stability Index post-test for both Females and Males-Static

	A/P Stability Index	Immediate	30 Minutes	60 Minutes
A/P Stability Index	Post-test for Females	2.47 ± 1.52	2.14 ± 1.27	3.27 ± 1.43
	Post-test for Males	3.4 ±1.42	3.11 ± 1.78	2.67 ± 1.42
	Independent t-value p value	-1.699 0.1 Insignificant	-1.723 0.096 Insignificant	-0.925 0.363 Insignificant

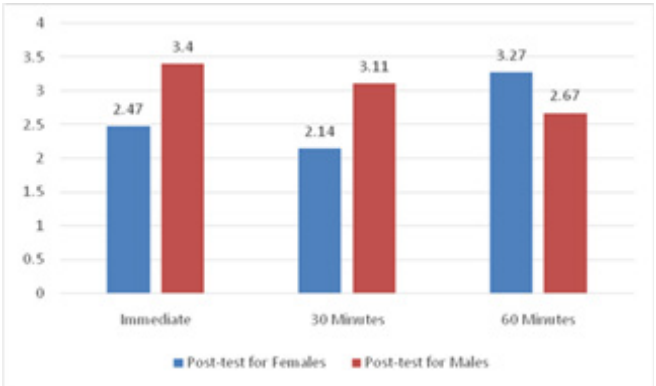

Figure 5.b: mean values and S.D of A/P Stability Index post-test for both Females and Males-Static

3) M/L Stability Index

Independent t-test was used to show a difference between immediate post-test for females and males. The female mean value of M/L Stability Index (2.2±1.07) was insignificantly different from (3.02 ± 1.28) with t-test = -1.898and p-value = 0.068.

Independent t-test was used to show a difference between 30 Minutes post-test for females and males. The female mean value of M/L stability index (2.12 ± 1.84) was insignificantly different from (2.52 ± 1.55) with t-test = -0.656and p-value = 0.518.

Independent t-test was used to show a difference between 60 Minutes post-test for females and males. The female mean value of M/L stability index (2.13 ± 1.98) was insignificantly different from (2.33 ± 1.02) with t-test =0.097and p-value = 0.729.

Table 5.c: The mean values and S.D of M/L Stability Index post-test for both Females and Males-Static

	M/L Stability Index	Immediate	30 Minutes	60 Minutes
M/L Stability Index	Post-test for Females	2.2 ± 1.07	2.12 ± 1.84	2.13 ±1.98
	Post-test for Males	3.02 ± 1.28	2.52 ± 1.55	2.33 ± 1.02
	Independent t-value p value	-1.898 0.068 Insignificant	-0.656 0.518 Insignificant	0.097 0.729 Insignificant

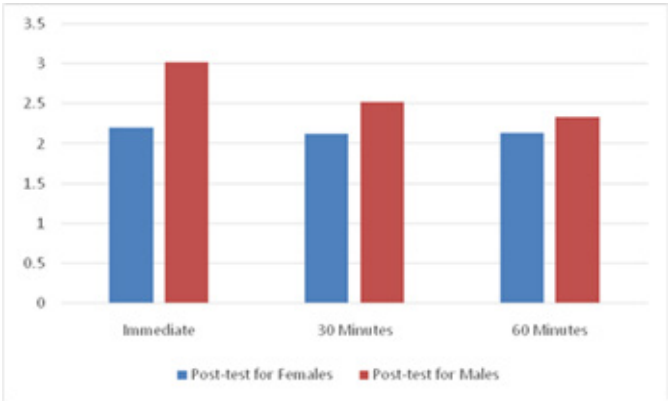

Figure 5.c: The mean values and S.D of M/L Stability Index post-test for both Females and Males-Static

DISCUSSION

The purposes of the study were to determine the immediate and late effect of cryotherapy on the dominant ankle joint on static balance and to establish the difference in static balance changes between both sexes.

Our result revealed that the females have a significant difference in static balance than male when measured before application of cold gel pack to dominant ankle extremity with p-value of overall stability index = 0.033, a p-value of A/P stability index=0.043 and not for ML stability index with a p value of =0.072.

Our result revealed that after using cold gel pack to dominant ankle extremity for 15 minutes has no statistically significant difference in all aspect of static balance in the female group. In over stability index, there was no statistically significant difference in assessment immediately, after 30 minutes and after 60 minutes with p-value =0.66. In over A/P stability index, there was no statistically significant difference in assessment immediately, after 30 minutes and after 60 minutes with p-value =0.196. And In over M/L stability index, there was no statistically significant difference in assessment immediately, after 30 minutes and after 60 minutes with p-value =0.989.

Also, the result revealed that after using cold gel pack to dominant ankle extremity for 15 minutes has no statistically significant difference in all aspect of static balance in males group. In over stability index there was no statistically significant difference after assessment immediately, after 30 minutes and after 60 minutes with p value =0.382, In over A/P stability index there was no statistically significant difference after assessment immediately, after 30 minutes and after 60 minutes with p-value =0.525 and In over M/L stability index there was no statistically significant difference after assessment immediately, after 30 minutes and after 60 minutes with p value =0.46.

In posttest, the difference between female and male in over stability index shows insignificantly difference immediately posttest with p-value 0.063, insignificantly difference 30 minutes posttest with p-value 0.23 and insignificantly difference 60 minutes posttest with p-value 0.682.

In A/P stability index shows insignificantly difference immediately posttest with p-value 0.1, insignificantly difference 30 minutes posttest with p-value 0.096 and insignificantly difference 60 minutes posttest with p-value 0.363.

In M/L stability index shows no significantly difference immediately posttest with p-value 0.068, insignificantly difference 30 minutes posttest with p-value 0.518 and insignificantly difference 60 minutes posttest with p-value 0.729.

So the application of cold gel pack to ankle dominant extremity for 15 minutes has no effect on all aspect of static balance, and this result may be due to that when the temperature of nerve decrease, the conduction velocity of nerve declines proportionally to duration and degree of change in the temperature. It isn't indistinguishable at the fibers which differ in diameters; rather investigates demonstrate cold has the highest impact on conduction by small fibers and myelinated and the smallest impact on conduction by large fibers and unmylinated.

A small diameter-myelinated and pain transmitting A-delta fibers show the highest reduction in conduction velocity as a reaction of the cooling [26]. But afferent fibers that responsible for the translation of the proprioceptive information from muscle spindle to the central nervous system are I Alfa and II meaning large myelinated fiber that has fast conduction [27]. So it is possible that is fewer affection by cooling.

These findings were consistent with previous studies. Douglas et al., 2013 found that there was no statistically significant difference in static balance after 15 minutes ice water immersion to ankle joint [22], also Williams et al., 2013 found that there was no statistically significant difference in static balance after 20 minutes crushed ice bag to the ankle joint [28], Costello and Donnelly, 2011 found that that there was no statistically significant difference in static balance after 30 minutes water immersion to the knee [29].

Ankle joint Immersion in cold water at 4–°C temperature for five, fifteen, and twenty minutes didn't significantly affect joint position sense of the ankle joint [30,31]. Immersion of the ankle joint and foot in cold water (1°C) didn't disturb sensory perception [32]. Cold water immersion thirty minutes duration to the umbilicus level didn't significantly change assessment of weight-bearing or non-weight-bearing for knee joint position sense [29]. The same results arise from an examination of the shoulder joint after the application of a cubed ice compress for thirty minutes [33].

These findings were contradicted by previous studies. Oliveira et al., 2010 found that there was statistically significant difference in knee position sense after 20 minutes crushed ice bag application to knee joint [34], also Surenkok et al., 2008 found that there was statistically significant difference in balance after 30 minutes cold pack to the knee joint [35], Wassinger et al., 2007 found that that there was statistically significant difference in static balance after 20 minutes ice bag to the shoulder extremity [36].all the previous studies maintain that application of cryotherapy locally affect deep feeling in the body, and they totally conclude deficits in neuromuscular and instruct against athletics immediately dynamic training after cryotherapy.

Limitation:

All subjects joining in this study had uninjured ankles. Because the injury of the subjects may affect study results.

CONCLUSION

The result of study suggests that 15 minutes of cold gel pack on ankle dominant extremity have no effect on static balance on both male.

Implementations:

The findings of the current study could be implemented in the following ways:

1. Decision making concerning utilizing of cryotherapy through treatment sitting or when considering come back to activity after an athletic injury.

Recommendations:

The results of this study considered the following recommendations:

1. Future studies can focus on the impact of different cryotherapy application on dynamic and static balance.
2. Future studies can focus on the effect of cryotherapy on different joints in static and dynamic balance.
3. Future studies can focus on the impact of cryotherapy on dynamic and static balance in the injured subject.
4. Future studies can focus on the impact of cryotherapy on dynamic and static balance in the athletic subject.

Abbreviations:

OSI: Overall Stability Index.
APSI: Anterior/Posterior stability Index.
MLSI: Medial/Lateral Stability Index.
T-Statistic: Un-Paired T-Test
p-value: Probability value.
* S: Significant
Pre: Pre-treatment
Post: Post-treatment.
SD: Standard Deviation.

MD: Mean Difference.
% of impr: Percentage of improvement.
F-statistics: ANOVA test

Acknowledgements

The authors express their thankful to all subjects who participated in the study.

Financial support and sponsorship

Nothing.

Conflicts of interest

There was no inconsistency of interest.

REFERENCE

[1] Zagrobelny Z, Zimmer K. Cryogenic temperatures application in sports medicine and physiotherapy. Med Sportowa. 1999;94(15):8-13.
[2] Jezierski, C. Methodology and principles of local cryostimulation techniques. Acta Bio – Optica et Informatica Medica. 2006; 3(12): 200 – 201
[3] Kennet J, Hardaker N, Hobbs S, Selfe J. Cooling efficiency of 4 common cryotherapeutic agents. Journal of Athletic Training. 2007 Jul 1;42(3):343.
[4] Kanlayanaphotporn R, Janwantanakul P. Comparison of skin surface temperature during the application of various cryotherapy modalities. Archives of physical medicine and rehabilitation. 2005 Jul 31;86(7):1411-1415.
[5] Cina-Tschumi B. Evidence-based impact of cryotherapy on postoperative pain, swelling, drainage and tolerance after orthopedic surgery. Pflege. 2007 Oct;20(5):258-67.
[6] Algafly AA, George KP. The effect of cryotherapy on nerve conduction velocity, pain threshold and pain tolerance. British journal of sports medicine. 2007 Jun 1;41(6):365-9.
[7] Bleakley C, McDonough S, MacAuley D. The use of ice in the treatment of acute soft-tissue injury a systematic review of randomized controlled trials. The American journal of sports medicine. 2004 Jan 1;32(1):251-261.
[8] Tee JC, Bosch AN, Lambert MI. Metabolic consequences of exercise-induced muscle damage. Sports Medicine. 2007 Oct 1;37(10):827-836.
[9] Bleakley CM, Costello JT, Glasgow PD. Should athletes return to sport after applying ice?. Sports Medicine. 2012 Jan 1;42(1):69-87.
[10] Ruiz DH, Myrer JW, Durrant E, Fellingham GW. Cryotherapy and sequential exercise bouts following cryotherapy on concentric and eccentric strength in the quadriceps. Journal of athletic training. 1993;28(4):320-323.
[11] Pereira L, Pereira R, Neto O, Magini M. The short and long term effects of tibialis anterior local cooling on dorsiflexion force. Journal of Human Kinetics. 2010 Dec 1;26:65-71.
[12] Schultz AB, Alexander NB, Ashton-Miller JA. Biomechanical analyses of rising from a chair. Journal of biomechanics. 1992 Dec 1;25(12):1383-1391.
[13] Berg K, Wood-Dauphine S, Williams JI, Gayton D. Measuring balance in the elderly: preliminary development of an instrument. Physiotherapy Canada. 1989 Nov;41(6):304-311.
[14] Hrysomallis C. Relationship between balance ability, training and sports injury risk. Sports Medicine. 2007 Jun 1;37(6):547-556.
[15] Salavati M, Moghadam M, Ebrahimi I, Arab AM. Changes in postural stability with fatigue of lower extremity frontal and sagittal plane movers. Gait & posture. 2007 Jul 31;26(2):214-218.
[16] Clark BC, Manini TM, Doldo NA, Ploutz-Snyder LL. Gender differences in skeletal muscle fatigability are related to contraction type and EMG spectral compression. Journal of Applied Physiology. 2003 Jun 1;94(6):2263-2272.
[17] Hirabayashi SI, Iwasaki Y. Developmental perspective of sensory organization on postural control. Brain and development. 1995 Mar 1;17(2):111-113.
[18] Kellis E, Kouvelioti V. Agonist versus antagonist muscle fatigue effects on thigh muscle activity and vertical ground reaction during drop landing. Journal of Electromyography and Kinesiology. 2009 Feb 28;19(1):55-64.
[19] Richendollar ML, Darby LA, Brown TM. Ice bag application, active warm-up, and 3 measures of maximal functional performance. Journal of athletic training. 2006 Oct 1;41(4):364-370.
[20] Ingersoll CD, Knight KL, Merrick MA. Sensory perception of the foot and ankle following therapeutic applications of heat and cold. Journal of athletic training. 1992;27(3):231-234.
[21] Arnold BL, Schmitz RJ. Examination of balance measures produced by the Biodex Stability System. Journal of athletic training. 1998 Oct;33(4):323-327.
[22] 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 1;8(1:)9-14.
[23] Pereira HM, de Campos TF, Santos MB, Cardoso JR, de Camargo Garcia M, Cohen M. Influence of knee position on the postural stability index registered by the Biodex Stability System. Gait & posture. 2008 Nov 30;28(4):668-672.
[24] Duecker, Jody. Measurement of Validity for Balance Assessments using a Modified CTSIB Sway Index Versus a Biodex Sway Index. Diss. The University of Akron.;2013.
[25] Paddon-Jones DJ, Quigley BM. Effect of cryotherapy on muscle soreness and strength following eccentric exercise. International journal of sports medicine. 1997 Nov;18(08):588-593.
[26] De Jesus PV, Hausmanowa-Petrusewicz I, Barchi RL. The effect of cold on nerve conduction of human slow and fast nerve fibers. Neurology. 1973 Nov 1;23(11):1182
[27] Cameron MH. Physical agents in rehabilitation: from research to practice. Elsevier Health Sciences; 2012

Oct 5.
[28] Williams ee, miller iii sj, sebastianelli wj, vairo gl. Original research. Comparative immediate functional outcomes among cryotherapeutic interventions at the ankle. International journal of sports physical therapy. 2013 dec 1;8(6): 828–837.
[29] Costello JT, Donnelly AE. Effects of cold water immersion on knee joint position sense in healthy volunteers. Journal of sports sciences. 2011 Mar 1;29(5):449-456.
[30] LaRiviere J, Osternig LR. The effect of ice immersion on joint position sense. Journal of Sport Rehabilitation. 1994 Feb;3(1):58-67.
[31] Someh M, Ghafarinejad F. The effect of cryotherapy on the normal ankle joint position sense. Asian journal of sports medicine. 2011 Jun 1;2(2):91-98.
[32] Ingersoll CD, Knight KL, Merrick MA. Sensory perception of the foot and ankle following therapeutic applications of heat and cold. Journal of athletic training. 1992;27(3):231-233.
[33] Dover G, Powers ME. Cryotherapy does not impair shoulder joint position sense. Archives of physical medicine and rehabilitation. 2004 Aug 31;85(8):1241-1246.
[34] Oliveira R, Ribeiro F, Oliveira J. Cryotherapy impairs knee joint position sense. International journal of sports medicine. 2010 Mar;31(03):198-201.
[35] Surenkok O, Aytar A, Tüzün EH, Akman MN. Cryotherapy impairs knee joint position sense and balance. Isokinetics and Exercise Science. 2008 Jan 1;16(1):69-73.
[36] Wassinger CA, Myers JB, Gatti JM, Conley KM, Lephart SM. Proprioception and throwing accuracy in the dominant shoulder after cryotherapy. Journal of Athletic Training. 2007 Jan 1;42(1):84-89.

Citation
Ahmed, Y. F., Abdel Raoof.N.A, El-Sayyad .M .M, & Amin, D. I. (2017). IMMEDIATE AND LATE EFFECT OF CRYOTHERAPY ON BALANCE IN HEALTHY SUBJECTS. *International Journal of Physiotherapy,* 4(2), 77-85.