Effect of Cryotherapy to Relieve Spasticity in Neurological Conditions - A Systematic Review

Dr. Salim Babulal Shaikh¹, Dr. Suvarna Shyam Ganvir (PhD) ²

¹MPT 1ST Year, Department of Neurophysiotherapy, DVVPF’s College of physiotherapy, Ahmednagar, India
²HOD and Professor, Department of Neurophysiotherapy, DVVPF’s College of Physiotherapy, Ahmednagar, India

Abstract: Background: Cryotherapy is one of the modalities frequently used to inhibit spasticity, the effect of which has been previously studied through the application of different measurements that show contradictory results. Objective: To investigate the literature evidence for the effect of Cryotherapy on spasticity in neurological conditions. Data Sources: This review contain latest literature, only Studies included within last 10 years. The keywords: Cryotherapy/ Cold therapy/Icing and spasticity, Physical therapy were entered into PubMed, Google scholar and Ovid databases, which included Medline, CINAHL, and Journals at Ovid full text, EBM reviews. Conclusion: Studies included in this review suggest that cryotherapy applied to the spastic muscles is effective in decreasing muscle tonus level.

Keywords: Cryotherapy, Cold therapy, Icing, Spasticity, Physical therapy

1. Introduction

Spasticity is recognized as a phenomenon of velocity-dependent increases in tonic stretch reflexes with exaggerated tendon reflexes resulting from hyper excitability of the stretch reflex 0

Spasticity in particular is considered as an important symptom that can restrict a patient's functional abilities and reduce their quality of life. When it affects the lower limbs, spasticity may have negative effects on balance, mobility, and gait and may also increase the risk of (falls and fractures in people who have experienced a stroke.0

The search for effective, practical techniques to reduce the spasticity, thus aiding the individual to achieve more normal activity, is an ongoing process. Although many suggested techniques seem to be effective in a laboratory setting, careful and critical evaluation is necessary to determine whether each technique is effective when employed in a clinical or practical setting.[2]

Cold treatment is broadly utilized as a medicinal treatment and this strategy is utilized in the management of different acute and chronic conditions. There are many microscopic effects that are promoted by applying cold therapy such as reduced swelling and oedema in injuries, increased local circulation, decreased acute inflammation that follows tissue damage, decreased muscle spasm, and restriction of pain. [3]

Cold therapy can facilitate muscle contraction and can be used to improve muscle contraction to increase joint motion after injury. Another cold therapy impact is a period - related spasticity decrease once the ice has been applied for a long time. [3]

Cold therapy can be applied to the body in three different ways: submerge the part in cold water, scour ice cubes or ice packs, or use evaporative sprays like ethyl chloride.[3]

Eldred et.al who reported that Ice application reduces muscle tone through a reduction of spindle sensitivity. They found that the rate of spontaneous spindle discharge decreases with decreasing temperature. [4], 5[7]

Michlovitz - stated that inhibition occurring due to the use of cryotherapy may be due to the local cooling effect on every component of the segmental sensorimotor complex including large afferent fibres of muscle spindle (both alpha and gamma motor neurons). [5], [7]

Cryotherapy is one of the modalities frequently used to inhibit spasticity, the effect of which has been previously studied through the application of different measurements that show contradictory results.[6]

Literature [7]-[17] reports that cryotherapy temporarily decreases spasticity, as well as deep tendon reflexes and clonus, due to decreased sensitivity of skin mechanoreceptors, slowed transmission of sensory and motor nerve fibres (alpha) or the decrease in the sensitivity to stretching of the neuromuscular spindle (NMH) and consequently, of the activity of the gamma system.

On the other hand, more recent studies [18]-[22] have established that the application of cryotherapy in the spastic person causes an increase in the maximum amplitude of the H response, in relation to the maximum amplitude of the M wave (Hmax / Mmax), suggesting reflex hyper excitability derived from the competitive effects of alpha and gamma motor neurons (MNs), caused by peripheral cooling.[23]

The aim of this study is to review the literature regarding the Cryotherapy to determine its effectiveness on spasticity.

2. Materials and Methods

This systematic review was carried out by using PubMed, Google scholar and Ovid databases, which included Medline, CINAHL, and Journals at Ovid full text, EBM reviews. We covered all the documents available on this
sources. We used the following indexing and text terms to search the data: Cryotherapy OR Cold therapy OR Icing, spasticity, Physical therapy.

The eligibility Criteria were: 1) Subjects diagnosed with spasticity from patients with hemiparesis. 2) Review contain latest literature, only Studies included within last 9 years i.e.2011-2019 3) Evaluation of spasticity level by means of qualitative (Ex- Modified Ashworth scale) and quantitative (Ex- dynamometric systems) methods. 5) Studies written in English. The studies that matched the criteria were subsequently examined for the inclusion.

3. Result

We screened out 30 articles out of which we selected 7 good qualities of article which showed the significant effect in reducing spasticity by various techniques of cryotherapy in different neurological conditions such as stroke, traumatic brain injury which leads to hemiparesis.

The age of patients was varied from 1 year to 75 years in the systematic review. The subject of five articles was diagnosed with stroke, another two studies included with traumatic brain injury.

Ice pack/Cold pack was given in four of the studies to Calf muscles (Plantar flexor muscles) for 20-30 minutes. Ice cube stroking, ice massage was given in four of the studies to Antagonist muscles, triceps surae, gastrocnemius muscles for 10-30 minutes in patients with hemiparesis secondary to stroke, and traumatic brain injury.

There was one study done which examined the immediate post 24 hours effect of cooling and sustained passive stretching as treatment techniques for reduction of spasticity in hemiplegic using H- reflex. The result of this study showed a significant decrease in the spasticity.[24]

One of the study done to investigate the effect of icing to reduce Spasticity, improving ankle range of motion and gait velocity in post stroke subjects. Total 30 participant who are hemiplegic patients with plantar flexor spasticity and walk independently were included. Result showed that icing decreases spasticity, and increases range of motion of ankle there by improving gait velocity.[25]

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<th>Summary Table</th>
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<td><strong>Study</strong></td>
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<td>Luccas Cavalcanti Garcia et. al. (2019)</td>
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<th>Authors</th>
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<tr>
<td>Jolanta Krukowska et al.</td>
<td>Experimental study</td>
<td>56 patients with post-stroke spasticity.</td>
<td>They were divided into two groups (Group 1 was administered cryotherapy and</td>
<td>Results: In the treatment groups decreased muscle tone. An improvement</td>
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<td>kinesiotherapy and Group 2- kinesiotherapy only)</td>
<td>of the efficiency of locomotion and hand in performing activities of daily living. More favourable results were observed in group 1.</td>
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<td>Dr. Barkakhurana et al.</td>
<td>Comparative experimental study</td>
<td>40 patient having tone of at least 3 or more on MAS of upper limb.</td>
<td>Treatment: The patient was divided into two groups, group A and group B. In</td>
<td>Conclusions: Local cryotherapy combined with kinesiotherapy appeared to be more effective in treating spasticity rather than kinesiotherapy alone. A decrease in spasticity and an improvement of the limb function indicate a stabilization of muscular tension in patients with disorders upper motor neuron.</td>
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<td>each group 20 patients were taken. Treatment was given for 6 days a week for 1 month in each group. Group A was treated with quick icing for 10 minutes on antagonus muscle. Group B was treated with long duration sustained stretch up to duration of 1 min.</td>
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<tr>
<td>Dr. Shrikant Darade</td>
<td>Experimental study</td>
<td>Total 30 participant who are hemiplegic patients with plantar flexor spasticity and walk independently were included. Treatment- Ice cube was taken in a turkay towel exposing one surface, and stroked over gastrosoleus slowly from origin to insertion, maintaining a continuous and direct contact for 30 minute</td>
<td>Modified Ashworth Scale, goniometry and velocity formula</td>
<td>This study thus concludes that prolonged sustained stretching have a significant impact on reduction of tone according to modified ashworth scale. The patient who received prolonged sustained stretching has better results. Thus groupB showed a significant reduction in tone as compared to group A Thus, concluded that sustained stretching on spastic agonist muscle is superior to quick icing on antagonist muscle.</td>
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<tr>
<td>Shilpa Khandare</td>
<td>Comparative experimental study</td>
<td>30 patients (male=21, female=09) were selected between the (aged 40-70 Yrs) with spastic hemiplegia due to cerebrovascular accident. They were divided into two groups with 15 patients in each group The affected side of the patient was considered as Study group A Cooling was given and Study group B Sustained Passive Stretching was given along with routine rehabilitation.</td>
<td>Modified Ashworth Scale,</td>
<td>Results: Our study did not find any statistically significant difference between cooling and sustained passive Stretching for reducing the hypertonicity in triceps surae muscles (p&lt;0.05). Conclusion: It is concluded that Cooling and Sustained passive stretching both are equally effective in reducing spasticity of tricepsurae muscles in patient with hemiplegia.</td>
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One of the article in which they investigated the comparison between sustained stretch to agonist muscle for one minute and quick icing to antagonist muscle for 10 minutes was done with the patients of hemiparesis secondary to chronic head injury. They concluded that sustained stretching on spastic agonist muscle is superior to quick icing on antagonist muscle. [26]
All the articles which we reviewed included various outcome measures. Six articles used MAS as an outcome measure for measuring grades of spasticity, one study used ‘A Biodex Multi-joint System 3 dynamometer to assess the joint position sense’. Some of the studies use the goniometry to check the joint ROM and use scale such as: Brunstrom scale.

One of the study used the exaggerated stretch reflex to measure spasticity, the α motor neuron excitability was assessed by measuring the latency of the Hoffmann reflex (H-reflex) and the ratio (Hmax: Mmax) of the amplitude of the H max to that of the maximum response of the spastic soleus muscle (M max).[6]

The articles included in this systematic review contain, 3 studies were the randomized controlled trial, 2 studies were the experimental study and 2 studies were comparative study. There were no case reports or case series were found in our selected literature search. Treatment time which used was up to an average of 15–35 minutes.

4. Discussion

Cryotherapy is one of the most commonly used interventions by physical therapist to reduce spasticity.

There are many possible underlying mechanisms that explain how cold therapy reduces spasticity. The first mechanism was explained by Eldred et al., Ottosn, and Knutsson and Mattsson who reported that ice application reduces muscle tone through a reduction of spindle sensitivity.[4] They found that the rate of spontaneous spindle discharge decreases with decreasing temperature. Also, the rate of discharge from the Golgi tendon organs was found to be temperature-dependent. The change in discharge of the muscle spindle may result from the effect of cold on extra fused muscle, the intrafusal fibres or the sensory endings. Similarly, Michlovitz et al. stated that inhibition occurring due to the use of cryotherapy may be due to the local cooling effect on every component of the segmental sensorimotor complex, including large afferent fibres of muscle spindles (both alpha and gamma motorneurons), all skin receptors, extrafusal muscle fibres and the myoneural junction.[5]

The second possible mechanism is explained by Lippold et al. who suggested that the effect of cold application is related to the role of change in membrane polarization. They found that hyperpolarization or low potassium concentration reduced or abolished spindle discharge. Also, their findings are in agreement with those of Eldred et al. and associates who concluded that the site of thermal effect is the sensory terminal itself and is likely to be the result of change in membrane stability similar to those included in axons by lowering the temperature.[7], [28]

Finally, Miglietta reported that clonus and spasticity are not abolished unless the muscle temperature drops significantly. He mentioned the possibility that sympathetic fibres stimulation by cold application not only produces vasoconstriction but also decreases spindle sensitivity.[7], [28]

This agrees with Urbschleit et al. who investigated the changes in H-response and the Achilles tendon jerk in hemiplegic patients after cold application. They found that the hemiplegic patients responded differently. The author suggested that local cooling might decrease, increase, or exert no effect on the spasticity.[7] The results of this study support the findings of Warren et al. who concluded that deep prolonged and penetrating cold could be used in therapy to induce relaxation. They attributed their findings to be due to lowering of the background level of stretch afferent input. They reported that deep cold (penetrating the muscle mass) produces cold block of the receptors or the afferent fibres themselves.

The previous work of Price et al. on the effect of cryotherapy on spasticity at the human ankle supports our results. They established that cryotherapy has an effect on reducing the path length, a parameter indicating the frequency dependent viscoelastic response at the ankle. High values of path length have been shown to be associated with the presence of spasticity. They recommended the use of cryotherapy for 1 h on the calf muscles aiming for spasticity reduction. [30]

The results of this study confirm the findings of Lehman and de Lateur who reported that cold application has been found useful to be used to reduce spasticity in upper motor neuron lesion and in muscle re-education to facilitate muscle contraction.[31]

One of the study done by Luccas Cavalcanti Garcia et. al on the ‘Cryotherapy Reduces Muscle Spasticity But Does Not Affect Proprioception in Ischemic Stroke’. The outcome measure they used were the A Biodex Multi-joint System 3 dynamometer, MAS. The result showed that cryotherapy temporarily reduces the degree of spasticity in the leg muscles without altering JPS in chronic hemiparetic stroke patients. It is important to highlight that the results observed in the present study specifically represent the effects of ice packs applied to the spastic muscle, which cannot be generalized to cryotherapy effects if they were applied to other areas, such as the joint.0

Another study done by Dr. Shrikant Darade et.al. on the topic ‘Can icing is help to reduce Spasticity, improving ankle range of motion and gait velocity in post stroke subjects’. The outcome measure he used were Modified Ashworth Scale, goniometry and velocity formula. The result showed that icing decreases spasticity, and increases range of motion of ankle there by improving gait velocity. The stimulus produced by cold have an inhibitory effect on the alpha motor neuron pool, which ultimately reduce spasticity.[25]

After reviewing all this studies, we have found that patient characteristics widely vary between and within all the studies. It all depend upon the neurological condition, nature, severity of the spasticity, it also depends upon the pathophysiology of the cryotherapy whether it originates from the spinal or brain level and according to it the effect of icing varies.
5. Conclusion

This systematic review contains the information regarding the effect of the cryotherapy in patients with hemiparesis. Most of the studies included in this review suggest that cryotherapy applied to the spastic muscles is effective in decreasing muscle tonus level.

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References


cryotherapy in patients with post-stroke spasticity.


