



The Effect of Exercise Therapy with Heat Therapy and Cryotherapy for Patients with Ankle Sprain: A Comparative Study

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KEYWORDS

Numerical pain rating scale (NPRS), dorsiflexors (DF), foot and ankle outcome score (FAOS).

ABSTRACT:

Background: Ankle sprain is one of the most common causes of pain and disability among individuals and primarily caused by with sudden twisting injury to the ankle and presents as severe pain, swelling, unable to walk with sustained amount of time leads to lack of ROM, reduced muscle strength and even functional disability. The heat therapy and cryotherapy along with conventional therapy is much helpful in regain ankle mobility, improved muscle strength and also minimize disability in early phase of recovery.

Objective: The aim of current study is to determine the effectiveness of cryotherapy therapy and heat therapy along with therapeutic exercise in ankle sprain.

Methodology: The Overall, 34 numbers of subjects with ankle sprain were selected as subjects who come under the inclusion criteria. So, total N-30 subjects were allocated into 2 groups i.e., 15 subjects in (Group A) and 15 subjects in (Group B) through simple random sampling method. Out of 30 subjects there were 12 male patients and 18 female patients. A Written Consent form was obtained from subjects after describe the intervention and its outcomes. A pre intervention assessment was done via Numerical pain rating scale (NPRS) for pain, Foot and Ankle Outcome Score [FAOS].

Group-A received exercise therapy along with heat therapy and **group- B** received exercise therapy along with cryotherapy. The treatment was given for 4 weeks; 5 sessions per week, 30-45 minutes/session once a day. Post intervention assessment was done after completion of 4 weeks.

Results: The data was evaluated by statistical analysis paired t test and unpaired t test was applied both groups show significant difference but group A i.e. exercise therapy along with heat therapy is associated with higher levels of improvement assessed by NPRS, FAOS. When compared to group-B which was intervened by exercise therapy along with cryotherapy.

Conclusion: There is a significant improvement in calf muscle strain after applying exercise therapy along with heat therapy

INTRODUCTION

An ankle sprain is an injury to one or more of the ligaments of ankle that provides stability. Ankle injury is one of the most common musculoskeletal injuries in athletes as well as in sedentary peoples.¹ It is one of the common acute soft tissue injuries.¹

Ankle sprains are the second most common sports injury after knee injuries. 85% of them affecting the lateral ligaments due to inward twisting.²

Ligaments of ankle joint consists of: 3 main sets



Medial ligaments/deltoid ligament: It is a multifascicular ligament connects medial malleolus to talus, calcaneus, and navicular bone.

Lateral ligaments complex: These ligaments connects lateral malleolus to the talus and calcaneus. The lateral ligaments has 3 parts:

- Anterior talofibular (ATFL)
- Posterior talofibular (PTFL)
- Calcaneofibular (CFL)

Syndesmotoc ligaments: These ligaments connects the tibia and fibula.

The ATFL is the most commonly injured ligament in the ankle.¹ These three sets of ligaments work together to provide stability to the ankle joint.

Ankle sprain frequently occur in sports. Accounting for an estimated 2 million injuries per year and 20 percent of all sports injuries in the United States.¹⁻³ the incidence has been estimated at one ankle sprain per 10000 people per day. The prevalence of ankle injury highest in basketball, ice skating, and soccer.⁷ The risk factors for ankle injuries are previous history of ankle sprain, inadequate stretching, athlete's sex, foot type, Limited dorsiflexion and generalized joint laxity etc. The most common mechanism of injury to the ankle ligaments is inversion of the foot which results in injury of lateral ligaments of ankle, first anterior talofibular ligament [ATFL] followed by calcaneofibular ligament and the posterior talofibular ligaments as well. Other mechanism of injury is eversion injury which results in damage to deltoid ligaments³ and hyperdorsiflexion trauma cause injury to syndesmotoc ligaments.

Ankle sprain is most prevalent among highly active individuals but can also affect less inactive peoples, more frequently affects women, children, and athletes who participate in indoor and field sports.⁴ and presents as a recurrent injury in approximately 19% to 31% of cases. Ankle sprain typically occur suddenly. An acute ankle sprain presents with Pain, Swelling, Bruising, Tenderness and Instability of the ankle etc.

GRADES OF ANKLE SPRAIN:

TABLE 1
Grades of Ankle Sprain

Sign/symptom	Grade I	Grade II	Grade III
Ligament tear	None	Partial	Complete
Loss of functional ability	Minimal	Some	Great
Pain	Minimal	Moderate	Severe
Swelling	Minimal	Moderate	Severe
Ecchymosis	Usually not	Common	Yes
Difficulty bearing weight	None	Usual	Almost always

Fig. 1 Showing grades of ankle sprain

Courtesy : Am Fam Physician 2006;74:1714-20, 1723-4, 1725-6.

The medical diagnosis of ankle sprain is made with the help imaging findings i.e. ultrasound and magnetic resonance imaging (MRI). The diagnosis should also be confirmed by detailed history and mechanism of injury, careful physical examination which include level of pain, onset of swelling, weight bearing status to detect partial or complete tear. Complete ankle sprain is best evaluated with the anterior drawer test can detect excessive anterior displacement of the talus on tibia or talar tilt test for calcaneofibular ligament instability.⁶ For rating of pain intensity numeric pain rating scale (NPRS) is used commonly and for disability the Foot and Ankle outcome score (FAOS) is a self-reported questionnaire consist of 42-item with 5 subscales: pain (9 items), other symptoms (7 items), activities of daily living (ADL) (17 items), sports/recreation (5 items), and quality of life (4 items). Each question is graded from 0 to 4 on a 5-point Likert scale (none, mild, moderate, severe, and extreme problems). The score ranging from 0 to 100 [score 0 indicates severe problems, score 5 indicates no problems].

First line of treatment for ankle sprain is PRICE treatment protocol (Protection, Rest, Ice, Compression and Elevation) to reduce pain, swelling and protect from further injury.¹⁴ Non operative management is effective for most ankle sprain (grade 1 and 2). Ankle sprain can be treated with physical therapy using several different techniques including electrotherapy, manual therapy, heat therapy, cryotherapy and therapeutic exercises i.e., muscle strength training, stability training. All this method of treatment helps in reducing edema and inflammation, facilitate recovery after trauma and reduces the use of pain relievers in patients with ankle sprain.



The current study includes heat therapy for reducing pain intensity and hasten recovery, that may due to the physiological effects of heat therapy includes vasodilation, increases in blood flow and metabolism, and TRP channel activation leads to pain relief and increased mobility. The application of low-level superficial heat activates temperature-sensitive nerve endings (thermoreceptors) which in turn, initiate signals that block the processing of pain signals (nociception) in spinal cord [13](#).

Heat therapy is commonly used immediate analgesic agent include in physiotherapy interventions. An increase in temperature tends to reduce the stiffness in fascial tissues. However, heat therapy led to increased metabolism and vasodilation, thus accelerating the healing processes by enhanced supply of nutrients and oxygen and removal of pain-inducing mediators.

Cryotherapy is used as a part of the RICE protocol, in acute phase of musculoskeletal injuries. Cryotherapy induces vasoconstriction via a sympathetic reflex, reduces blood flow to the tissues, decreasing blood flow implies reduction of edema and slower delivery of inflammatory mediators to the injured area, meaning reduced inflammation. The decreased metabolic demand in the cooled zone also prevents secondary hypoxia-related damage.

In addition, Cryotherapy produces local anesthesia by decreasing the activation threshold of tissue nociceptors and nerve conduction velocity. Finally, decreasing muscle temperature also reduces muscle spasm via inhibition of a spinal cord reflex loop. A cryotherapy provides numbness to the injured area after that the patient can perform weight bearing exercises without pain.

Previous studies have shown that Cryotherapy is useful modality to reduce pain and improve the loading on injured leg, helps to minimize functional limitations of patients with sprained ankle. Therapeutic exercise consists of gentle Stretching, eccentric exercises, resisted exercises, balance training etc. important to improving the ROM. When the muscle is stretched, the force of the stretch is transmitted to the muscle fibers through the connective tissue in and around the fibers. When the initial stretching occurs in the sequential elastic component, the tension rises sharply.

After that, a mechanical defect occurs in the cross bridges as the filaments slip apart resulting in a sudden

lengthening of the sarcomere known as sarcomere giving. When the stretching force is released, the individual sarcomere returns to the rest length.

External ankle support, ankle disk training exercises, taping, proprioceptive neuromuscular facilitation exercises or training regimens, proprioceptive balance board training and bracing prevents ankle sprains in high-risk sporting activities.

METHODOLOGY

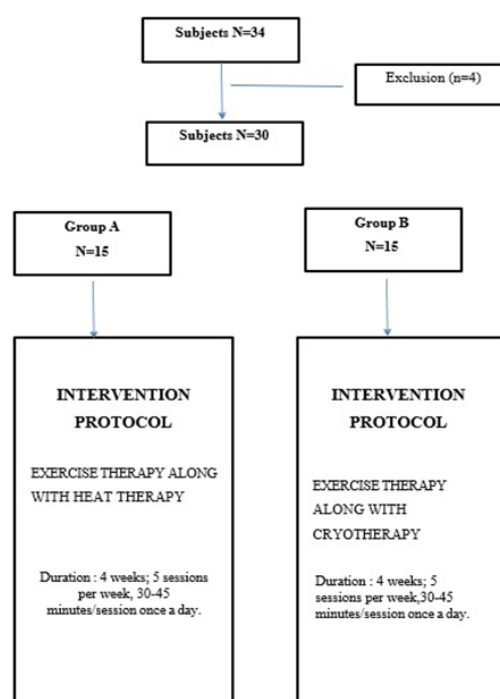


Fig 2. Model Framework of Procedure

OUTCOME MESURES

Numeric Pain Rating Scale (NPRS) : The NPRS is 11-point scale, used to measure the intensity of pain in adults. NPRS is numeric version of the visual analog scale (VAS) in which participants choose a whole number (0–10 integers) that best indicates the intensity of his/her pain. NPRS score ranging from 0 to 10 [score 0 indicates no pain, score 10 indicate severe pain sciatica]. Reliability ($r = 0.96$ and 0.95 respectively) and validity: (0.86 to 0.95).

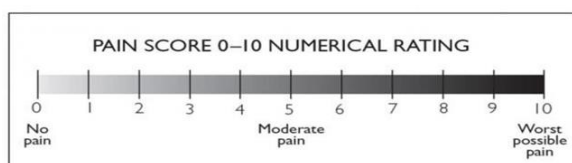


Fig 3. Numeric Pain Rating Scale (NPRS)

Foot and ankle outcome score (FAOS): Foot and Ankle outcome score is a self-reported questionnaire consist of 42-item with 5 subscales: pain (9 items), other symptoms (7 items), activities of daily living (ADL) (17 items), sports/recreation (5 items), and quality of life (4 items). Each question is graded from 0 to 4 on a 5-point Likert scale (none, mild, moderate, severe, and extreme problems). The score ranging from 0 to 100 [score 0 indicates severe problems, score 5 indicates no problems].

INTERVENTION

GROUP A – Heat therapy with therapeutic exercises

The technique of application for heat therapy

- Assess the part to be treated first.
- Tank with hot water at the temperature of $40^{\circ}\text{C} \pm 5^{\circ}\text{C}$ was used to apply heat modality in this study.
- The ankle joint of the involved extremity was immersed in the water tank.
- Limit heat application session to 20 mins as a good general rule.
- The skin needs to be checked every few minutes for signs of burns.

GROUP B – Cryotherapy along with therapeutic exercises

- The mode of cryotherapy was standardised and consisted of melting iced water (0°C) in a standard sized pack.^{13 14} Plastic ice bags (20 cm*20 cm) were completely filled with water, placed in a freezer, and removed when frozen. Before application, the packs were held under hot water for 30 seconds and wrapped in a single layer of standardised towelling (moistened until just dripping wet).
- This duration of treatment has been recommended in the literature^{10 15} and is also commonly used in the clinical setting.¹⁵ The intermittent ice group

applied ice for 10 minutes. The pack was then removed, and the ankle was rested at room temperature for 10 minutes. The ice was then reapplied for a further 10 minutes.

- Again intermittent treatments were repeated every two hours. Previous studies^{13 14} have shown that the mode and duration of cryotherapy applied in the intermittent protocol reduces skin temperature to 5°C immediately after treatment. [C M Bleakley et, al]

THERAPEUTIC EXERCISES

Common for both groups group A group B

[Physical therapy rehabilitation program approved by the Clinical Practice Guidelines]

FIRST-WEEK:

- Immobilization by bracing and external support.
- Therapeutic exercises: active ROM (ankle pumps), active assisted eversion/inversion,
- stretching exercises
- Neuromuscular training through towel curls.

SECOND WEEK:

- Resisted ankle ROM through resisted dorsiflexion/plantar-flexion, resisted inversion/eversion,
- postural re-education - toe raises and heel walking,
- Balance training - lunging on stable/un-stable surfaces, step-ups/downs, lateral step-ups/downs and Single-leg stance with lower limb.

THIRD AND FOURTH WEEKS

Exercise progressed to:

- Mini squat on an unstable surface,
- Single-leg stance while playing catch,
- Single-leg stance while playing with the coach,
- Single-leg stance with lower limb movement and



- Single leg stance with lower-limb movement on an unstable surface.

Duration – 4 weeks; 5 sessions per week, 30- 45 minutes/session once a day.

RESULT

A total 30 patients with calf strain were taken for statistical analysis and the collected information of all these subjects were entered into the computer database. The data was analyzed by using IBM SPSS version 20.0 (statistical package for social sciences) and the results on continuous measurements were presented in numbers (%).

The probability value, $p > 0.05$ was considered as statistically insignificant but the probability value from $p < 0.08$ to $p < 0.06$ was view as suggestively or poorly significant. However, the probability value from $p < 0.05$ to $p < 0.02$ was concede as statistically significant while from $p < 0.01$ to $p < 0.001$ was reflect as statistically highly/strongly significant.

Group A and Group B inter group analysis: This two techniques heat therapy along with exercise therapy (group A) and cryotherapy along with exercise therapy (group B) were compared, Pre and post intervention assessment was done through NPRS and FAOS as outcome measures beginning and end of 4 weeks. The gathered data was statistically analyzed by using unpaired t test for inter group analysis (between group A and group B)

TABLE NO. 1: Comparison of pre and post intervention scores of NPRS and FAOS between group A and group B.

Variable	Group code	Mean±SD	unpaired t test	p-value
NPRS pre	A	11.65±1.53	0.653	0.518
	B	9.45±1.918		
FAOS pre	A	11.55±3.18	4.134	<0.0001
	B	10.46±1.050		
	A	6.25±1.29		

NPRS post	B	5.00±1.124	0.739	0.464
FAOS post	A	4.05±1.57	4.132	<0.0001
	B	4.70±1.418		

In the above table (table no.1) shows that singly both groups were effective, but when compared with each other the post intervention score of NPRS and FAOS (Mean±SD) of group A (6.25±1.29 and 4.05±1.57) and group B (5.00±1.124 and 4.70±1.418) after 4 weeks indicates that group A showed significant improvement when compared to group B.

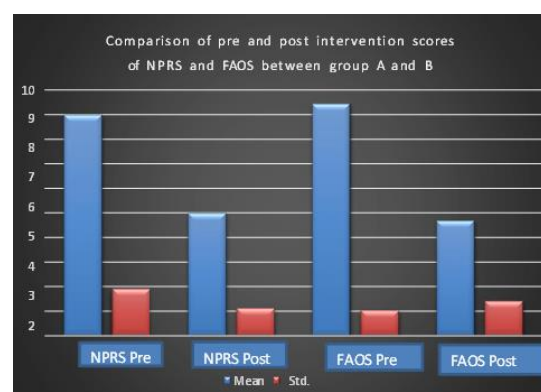


Fig. 4 Graph represent Comparison of NPRS and FAOS pre and post intervention scores in group A and group B

DISCUSSION

The purpose of this study was to assess which group of intervention was more effective in reducing pain, swelling, and increasing range of movement (ROM) thus, by minimizing functional limitation caused by ankle sprain. Pain, swelling and disability is very common among individuals who suffer from ankle sprain. Therefore, for rapid recovery use of thermal modalities such as heat therapy and cryotherapy along with therapeutic exercise are beneficial to obtain better prognosis and outcomes.

The current study was conducted to compare the effectiveness of heat therapy and cryotherapy on the level of pain and disability in patients with ankle sprain. The result showed a significant difference between the group A and B ($P < 0.0001$) on NPRS and FAOS that means heat therapy were found to be effective in improving pain and ROM as compared to cryotherapy in patients with ankle



sprain. The result also revealed a significant difference ($P < 0.0001$) within the groups calculated by pre and post intervention score of NPRS and FAOS. Group B i.e., cryotherapy also showed a significant difference ($P < 0.0001$) in pre and post intervention values of NPRS and FAOS. So, this result suggest that cryotherapy is also a helpful way to improve pain and muscle strength in calf muscle strain patients. This study results indicates that implementation of heat therapy along with therapeutic exercise for 4 weeks is much better than cryotherapy to reduce pain and disability in ankle sprain individuals. Similar results was produced using the same technique in previous literatures.

The current study confirms the effectiveness of heat therapy in reducing pain intensity and improve muscle strength that may due to the physiological effects of heat therapy includes vasodilation, increases in blood flow and metabolism, and TRP channel activation leads to pain relief and increased mobility. The application of low-level superficial heat activates temperature-sensitive nerve endings (thermoreceptors), which in turn, initiate signals that block the processing of pain signals (nociception) in spinal cord [13](#). The analgesic effects of heat are partly mediated by TRPV1 receptors, which facilitate the neural transduction of heat and the processing of nociceptive pain. The activation of TRPV1 receptors in the brain is thought to regulate anti-nociceptive pathways. These mechanisms serve to reduce muscle tonicity and relax muscles, thereby reducing pain and increasing flexibility.

Another explanation for heat therapy is that it is commonly used immediate analgesic agent in physiotherapy interventions. An increase in temperature tends to reduce the stiffness in fascial tissues. However heat therapy lead to increased metabolism and vasodilation, thus accelerating the healing processes by enhanced supply of nutrients and oxygen and removal of pain-inducing mediators. An elevation in tissue temperature of just 1°C is associated with a 10%–15% increase in the local metabolism. Recent evidence also suggests that localized, repeated HT may promote an angiogenic environment and enhance muscle strength.

All of the above when heat therapy uses with therapeutic exercises, its effect will maintain for longer period of time because connective tissues may also change in viscosity and density in response to heat, thereby enhancing tissue extensibility. So, this study mainly focuses on heat therapy which will be helpful in relieving pain and faster recovery process by its healing effect in

in ankle sprain. Literature [[Gerard A. Malanga et, al](#)] also support that the heat-wrap therapy provides short-term reductions in pain and disability in patients with ankle sprain and provides significantly greater pain relief. [[Roberto Rossi et al](#)] suggest heat therapy represents an effective, safe and inexpensive treatment applicable in different musculoskeletal pathologies.

The Cryotherapy along with therapeutic exercise also shows significant changes ($P < 0.0001$) in pain intensity and functional disability assessed by pre and post intervention score of NPRS and FAOS. Cryotherapy is used as a part of the RICE protocol, in acute phase of musculoskeletal injuries. Cryotherapy induces vasoconstriction via a sympathetic reflex, reduces blood flow to the tissues, Decreasing blood flow implies reduction of edema and slower delivery of inflammatory mediators to the injured area, meaning reduced inflammation. The decreased metabolic demand in the cooled zone also prevents secondary hypoxia-related damage.

In addition, Cryotherapy produces local anesthesia by decreasing the activation threshold of tissue nociceptors and nerve conduction velocity. Finally, decreasing muscle temperature also reduces muscle spasm via inhibition of a spinal cord reflex loop. A cryotherapy provide numbness to the injured area after that the patient can perform weight bearing exercises without pain.

Previous studies have shown that Cryotherapy is useful modality to reduce pain and improve the loading on injured leg, helps to minimize functional limitations of patients with sprained ankle. [[John E. Hocutt, JR., M.D. et, al](#)] study suggested that the cryotherapy started within 36 hours after the injury was more effective for complete and rapid recovery. Therefore, early use of cryotherapy, continued with adhesive compression, is an effective treatment of ankle sprains yielding earlier complete recovery. Some studies also suggest that, Ice applied to muscles appears to have a local anaesthetic rather than an analgesic action.

It is a cost effecting, easy to apply and noninvasive treatment procedure. Cryotherapy produces quick effect even after first application and completely resolves the pain within a short period. This study was deliberate to find the effectiveness of Cryotherapy in regain ROM and reduce pain intensity in ankle sprain. Following statistical analysis establish increase in post intervention score in NPRS and FAOS. So, both this techniques heat therapy in subacute stage and Cryotherapy in acute stage



can be used in clinical practice to lighten pain and improve ROM in patients with ankle sprain for speedy recovery.

CONCLUSION

This study concluded that both Heat therapy and Cryotherapy along with therapeutic exercise showed statistically significant ($p < 0.0001$) improvement in muscle strength, ROM and pain in patients with ankle sprain. But when compared between the groups, group A showed statistically significant ($p < 0.0001$) difference on NPRS and FAOS scores after 4 weeks of intervention than group B. Thus, addition of thermal modalities along with therapeutic exercise is more beneficial in increasing muscle strength, reducing pain and minimize disability leading to faster recovery in ankle sprain.

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