Effects of Cryotherapy After Soft Tissue Injury: A Systematic Review

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Abstract:

Background: Cryotherapy or ice therapy is used worldwide among medical professionals and layman to treat soft tissue injuries (STI). Despite its vast usage, disputing reports, on the effectiveness of cryotherapy existed in treating STI. Therefore, this study aims to review the effects of cryotherapy on pain reduction and time taken to return to normal activity after soft tissue injury. **Methods**: The review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. All the articles published in English-language within the year 2016 to 2021 were selected using databases, namely, Science Direct, PubMed, and Cochrane library. The risk of bias was assessed according to the handbook of Revised Cochrane Risk-of-Bias Tool for Randomized Trials. **Results**: Only 3 articles out of 178 articles fulfilled the inclusion criteria and were included for the systematic review. Only one article has some concerns of bias while the rest were low risk . Significant difference can be seen in terms of pain measured in VAS score when cryotherapy is applied either alone or together with manual therapy ($p<0.05$). One hundred and sixty-one patients who received cryotherapy out of 179 patients from 3 articles reported an average of 2.3 VAS score reduction from their initial score. However, there were no study that specifically include time taken to return to normal activity as an outcome measure. **Conclusion**: Cryotherapy is practical in treating soft tissue injuries, but it is recommended to incorporate manual treatments and exercises to achieve normal functional ability.

Keywords: cryotherapy, ice therapy, soft tissue injuries, return to activity

Introduction:

Cryotherapy or icing is a commonly used modality to treat soft tissue injuries such as ligament sprains as it will serve as a numbing agent to reduce pain (Bleakley, McDonough & MacAuley, 2004). Even though cryotherapy had been widely practiced among therapists and laymen, Tseng et al. (2013) had reported that the use of topical cooling after an acute exercise-induced muscle injury delays the recovery process, increases fatigue and pain level of the patients' injured site. For patients to return to normal activity, they must be cleared from their symptoms and improve their functional skills (Nelson & Butterwick,1989). Pritchard and Saliba (2014) described that topical cooling or cryotherapy application may reduce performance of the patients. This defeats the purpose of applying cryotherapy as it is an unwanted effect, however, Collins (2008) reported that cryotherapy application to an injury showed a definite benefit in reducing pain and disability.

These contradicting reports need to be investigated to find out the best intervention to reduce the time taken to return to activity after cryotherapy treatment. With regards to pain management, ice therapy is arguably a good and harmless approach to practice but there has been an ongoing debate when it comes to healing process of the injury. Thus, the purpose of this study was to review whether cryotherapy application is practical in pain management and affects recovery process by using current evidence.

Materials and Methods:

Systematic review process

This study used the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines as a method to aid in reporting the findings. The PRISMA guidelines include identification, screening, eligibility, and included criteria.

Search strategy

All articles were searched via databases and other search engines. The articles were sought from ScienceDirect, PubMed, and Cochrane library. The searching procedure utilized Boolean operators 'AND', 'OR' and 'NOT'. The following combination of terms: "Cryotherapy" OR "ice therapy" OR "ice" OR "icing" with the combination of "soft tissue injuries" AND "return to normal activity" OR "return to sport" were applied into the databases mentioned.

Inclusion criteria

Full-text English language literatures that were published within 5 years (2016-2021), with research articles must involve patients with soft tissue injuries. The exclusion criteria include review articles, patients with fractures, arthritis, and surgical wounds.

Methods of the review

Articles were screened and reviewed for their eligibility according to the inclusion and exclusion criteria based on their title and abstract. Articles that fulfill the requirements were included to be reviewed. The data were presented in table form adapted from the Guidelines of Systematic Reviews by the American Occupational Therapy Association (AOTA), updated in December 2020. To assess the risk of bias for the selected studies, the Revised Cochrane risk-of-bias tool for randomized trials (RoB 2) by the Cochrane collaboration was referred. The data includes the author's information, year of publication, study design, risk of bias, number of participants, and outcome measure as shown in Table 1.

Results:

The article selection process is simplified in PRISMA flow diagram as shown in Figure 1. A total of 178 articles were sought from the online databases namely, ScienceDirect, PubMed, and Cochrane library. Only 3 duplicates were identified and removed from the collection, and that leads to 175 articles to be screened by their title or abstract. After screening by their title and abstract, 139 articles were able to be excluded. Next, 36 remaining articles were evaluated according to the inclusion and exclusion criteria. Out of 36 articles, 33 of them were removed, finalized full-text articles remaining three (3) papers were included in the systematic review.

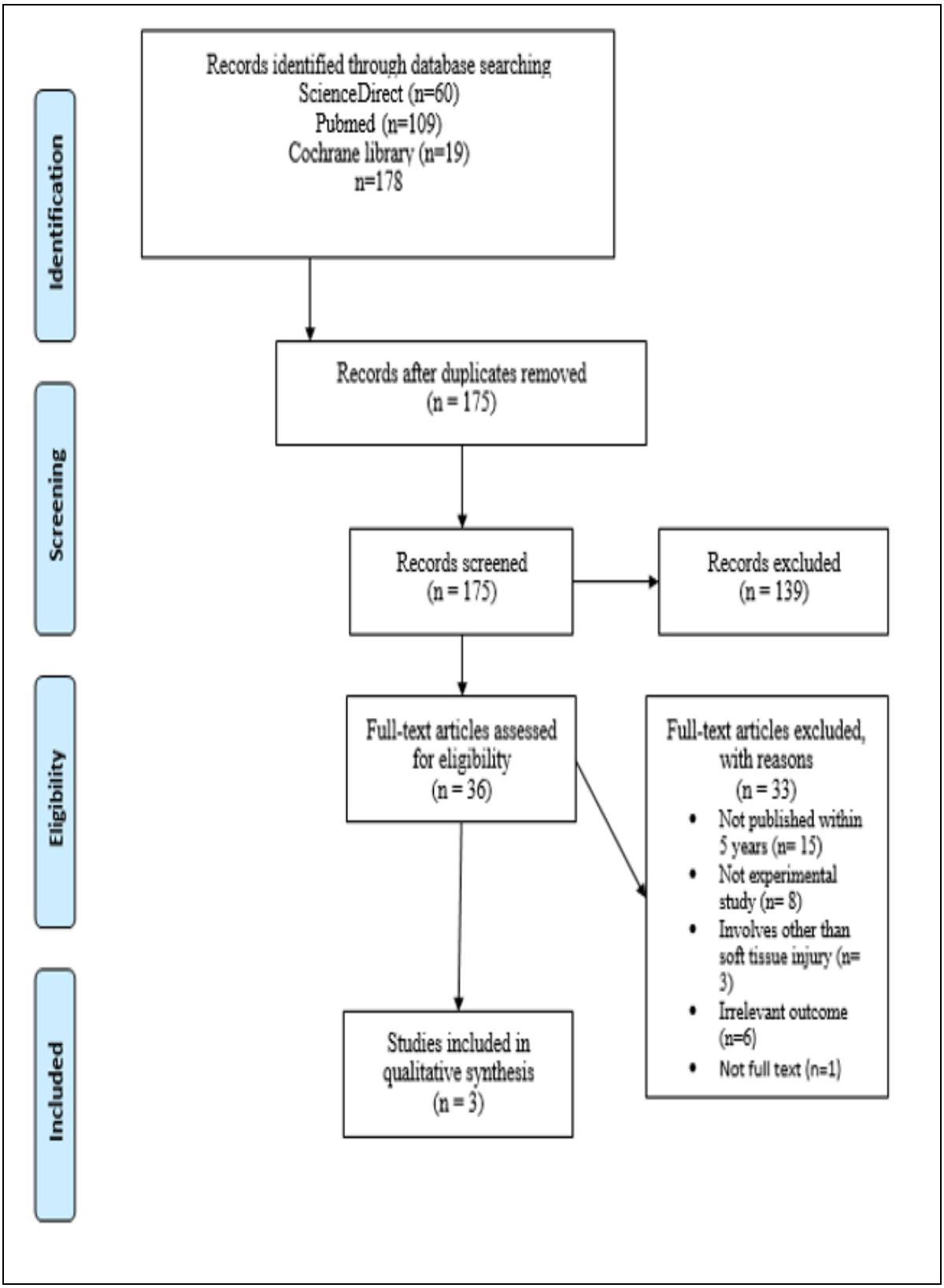

Figure 1 PRISMA flow diagram (Moher et al.,2009

Table 1 Characteristics of included studies

Author/ Year	Level of Evidence Study Design Risk of Bias	Participants Inclusion Criteria Study Settings	Intervention	Outcome Measures	Results
Mutlu and Yılmaz (2020)	Level 1B RCT *Risk of Bias* *Low*	*N = 105* (n = 35 10 minutes group (I), n = 35 20 minutes group (II), 35 30 minutes group (III)) *Inclusion criteria* 1) STI at ankle 2) No fractures or open wounds *Study setting* Emergency department of a university hospital in Turkey	*(n = 35)* Group I: cryotherapy applied for 10 minutes. (n=35) Group II: cryotherapy applied for 20 minutes. (n=35) Group III: Cryotherapy applied for 30 minutes. All patients were evaluated at 3 points immediately, 10 minutes, and 20 minutes after application	*Patient discomfort* (VAS immediately, 10 mins and 20 mins after application of cryotherapy, NSNS) *Ankle mobility* (ROM pre and post-intervention) *Edema* (Tape measure of joint circumference)	*Significant findings* • VAS pain score of Group II is significantly lower than other groups. ($p< 0.05$) • Joint mobility of group II is higher than other groups. ($p< 0.05$). *Non-significant findings* • There were no significant changes in joint circumference measurements ($p> 0.05$)
Sefiddashti, Ghotbi, Salavati, Farhadi, and Mazaheri (2018)	Level 1B RCT *Risk of Bias* Low	*Participants* *N = 37* (n = 19 cryotherapy group, n = 18 cryostretching) *Inclusion criteria* 1) Hamstring strain 2) No fractures or open wounds *Study setting* Physical therapy clinic in Iran	*(n = 37)* Cryotherapy group: (n= 19) Ice bags are placed at the injured site for 20 minutes. Cryostretching group: (n= 18) Ice bags are placed at the injured site for 20 minutes. Participants then perform static hamstring stretching for 30 seconds (10 secs, 3 sets) Repeated for 4-5 times per day, for 5 days.	*Pain* VAS at rest and during activity *ROM* AKE and PKE assessed using inclinometer. *Functional status* Persian-version of LEFS was used.	*Significant findings* • Larger improvement of ROM for PKE in cryostretching group compared to cryotherapy group. ($p< 0.05$) • Cryostretching group showed significantly larger improvement in LEFS score compared to cryotherapy group. ($p< 0.05$) *Non-significant findings* • Slight larger improvement of pain in cryostretching group than cryotherapy group but not significant.

Richer, Marchand, and Descarreaux (2017)	Level 2B Pilot Control Trial *Risk of Bias* Some concerns	*Participants* *N = 37* (n = 19 manual therapy group, n = 18 Cryostimulation + Manual therapy Group) *Inclusion criteria* 1) Chronic LE (>5 months) 2) No fractures or underlying conditions at the involved limb *Study setting* University-based chiropractic clinic	*(Manual therapy group, n = 19)* • Ischemic pressure on myofascial points. • Mobilization of the radial head (Mill's manipulation) *(Cryostimulation + Manual therapy group, n = 19)* • Cryostimulation using hyperbaric gaseous cryotherapy machine until the skin temperature reach 4°C after manual therapy is given. Both groups were given 8 treatments in the span of 8 weeks (2 treatments per week)	*Pain* VAS *Strength* PFGS measured using handheld dynamometer. *Functionality* PRTEE questionnaire.	*Significant findings* Both groups showed significant improvement in pain and disability (PRTEE) score post-treatment and after 3 months follow-up ($p < 0.01$) *Non-significant findings* PFGS measurements pre and post treatment showed no significant findings.

Note. VAS = Visual Analog Scale; ROM= Range of motion; AKE= Active Knee Extension; PKE= Passive Knee Extension; LEFS= Lower Extremity Functional Scale; LE= Lateral Epicondylitis; PFGS= Pain-Free Grip Strength; PRTEE= Patient Rated Tennis Elbow Evaluation; NSNS= The Newcastle Satisfaction with Nursing Scale

Description of included studies

The age of participants in the articles included in this review were all above 18 years old. All articles involved male and female patients and the number of participants in each article ranged from 37 to 105 participants. Participants recruited in the articles were diagnosed with either acute or chronic soft tissue injury, confirmed by medical imaging and special tests done by physical therapists and emergency department staff. Based on the criteria proposed in the Revised Cochrane risk-of-bias tool for randomized trials (RoB 2), one article was judged to have some concerns while the other two articles had low risk of bias.

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Discussion:

All participants in the included studies had pain as their symptoms that was assessed using VAS pain score. Throughout all these studies, there was a consistent result of pain reduction after application of cryotherapy on injured area. All the participants from the three studies included in this review had shown a reduction of pain after cryotherapy administration even through from different methods. Mutlu and Yılmaz (2020) in their study, emphasized on the duration to apply cryotherapy and it showed that the group that received 20 minutes of cryotherapy

experienced significant pain reduction ($p < 0.05$) that was measured by VAS pain score compared to the groups that received 10 minutes and 30 minutes of cryotherapy consecutively. Richer et al. (2017) and Sefiddashti et al. (2018) showed a better reduction of pain when cryotherapy is combined with manual treatments such as stretching, trigger point treatment and mobilization.

Cryotherapy is effective on pain is due to the reduced of nerve conduction velocity (NCV) (Algafly & George, 2007). A reduction in tissue temperature reduces the NCV in sensory and motor nerves exhibit therapeutic effect thus increase in pain threshold and tolerance (Algafly & George, 2007; Herrera et al., 2010). Nevertheless, the effectiveness of cold therapy on pain was speculated to be associated with the type of the STI. Tseng et al. (2013) mentioned that topical cooling can relieve pain after surgery and acute traumatic tissue injury, but not on pain from exercise-induced muscle injury. Exercise-induced muscle injury has different mechanism as topical cooling seems to aggravate the pain (Tseng et al., 2013). In addition, cryotherapy effect in retarding secondary tissue death due to hypoxia (Hubbard et al., 2004). It reduces blood flow to the area, therefore limiting the rate of chemical reactions and demand for adenosine triphosphate (ATP), resulting in longer survival of the tissue. Furthermore, the effect of topical cooling is reported to be for only for short term period. Bleakley et al. (2004) found out that cryotherapy is effective in reducing pain and swelling immediately after application to only one week post injury. Similarly, Mutlu and Yilmaz (2020) reported that after application of cryotherapy, it only takes 20 minutes for the pain score to start to elevate, meaning the effect is short term and temporary.

Pain management has been a primary goal for therapists as when pain is managed, they can safely start progressing to other advanced form of rehabilitation (Hubbard, Aronson & Denegar, 2004). Heat modality is a good low-cost intervention and a good alternative in handling muscle injuries (Malanga et al., 2014). Topical cooling has been a choice for clinicians because it is cost effective, non-invasive, and a safe modality to be used to patients. The desired analgesic effect given by cryotherapy application is why clinicians still use cryotherapy to manage pain. It can be said that cryotherapy can reduce pain. As mentioned in these three articles, 161 out of 179 patients demonstrated average reduction of 2.3 average VAS score after receiving cryotherapy.

Nevertheless, there was no included article mentioned the time taken to return to normal activity. Functional capabilities should be addressed as a precursor for patients to be cleared to return to normal activity. Functional status was recorded via questionnaires and the study by Sefiddashti et al. (2018) and Richer et al.(2017) detailed that there were significant improvements of functionality after cryostretching treatment and cryotherapy together with manual treatments.

The experiment by Seffidashti et al. (2018) reported an improvement of functional ability when cryostretching is applied compared to only cryotherapy. They reported significant difference between the effect on functionality after cryotherapy and cryostretching indicates that the therapeutic effects of stretching overlaid the effects of cold application. Cryostretching involve combination with therapeutic exercises. Järvinen (2005) explained that stretching can be a mode of stress delivery or loading that can stimulate growth factors involved in tissue regeneration. Gentle stretching also helps to reinstate tensile strength of the tissue by promoting more rapid growth of capillary blood vessels, or in other words, facilitate healing (Järvinen, 2005). Similar with the article by Richer, Marchand, and Descerreaux (2017), the effect of manual therapy helps in facilitating the healing process, therefore, improve functionality. This is supported by the study by Bleakley et al. (2007) in which cryokinetics showed significant improvements in short term ankle function compared to standard cryotherapy.

Tseng et al. (2013) claimed that cryotherapy delays the recovery process of exercise-induced muscle injury by slowing the release of inflammatory cytokines. The therapeutic effect can increase blood flow and metabolism makes it a good modality to speed up healing process of an injury (Nadler et.al, 2004). However, different in mechanism of injury and healing may contribute to different results. Therefore, this may explain the big void presence in literature in terms cryotherapy and time taken to return to normal activity. In addition, the current review has limitation in terms of papers selected based on inclusion and exclusion criteria. Further studies can be performed by emphasizing on combination therapy as well as incorporating more add more outcome measures.

Conclusion:

Cryotherapy showed to reduce pain in soft tissue injury. Twenty minutes is the recommended duration for cryotherapy application. The improvements in terms of functionality, strength, and mobility are further potentiated when combined with manual treatments. Nevertheless, there was no specific result on whether cryotherapy is effective in reducing the time taken to return to normal activity.

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