Update for Chapter 4: What is the role of ice in the treatment of acute soft tissue injuries?

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Introduction

In this review we systematically summarise the evidence for the effectiveness of ice in the treatment of acute soft tissue injuries. The objectives are:

1. To identify randomised-controlled studies assessing the effect of cryotherapy on acutely injured human subjects.
2. To assess for the presence of confounding concomitant therapies.
3. To study the modes, duration and frequency of cryotherapy treatments employed, and assess for evidence of an optimal treatment protocol.
4. To identify when cryotherapy was initiated in relation to the injury, and study the goals of treatment in each study ie. for immediate care or rehabilitation.

Methods

Search strategy and quality assessment

A computerised literature search, citation tracking and hand searching was carried out up to April 2002. Eligible studies were randomised-controlled trials, describing human subjects, recovering from acute soft tissue injuries, and employing a cryotherapy treatment in isolation or in combination other therapies. Two reviewers independently assessed the validity of included trials using the PEDro scale (Appendix 1) (ptwww.cchs.usyd.edu.au/pedro).

Results

From the initial examination of citations yielded from the literature search, 55 studies were included. After review of the complete texts, 33 studies were excluded; leaving 22 eligible randomized controlled trials, to be included in the review.

Methodological quality

Generally the methodological quality of studies was low. The final PEDro scores ranged from 1-5, with a mean PEDro score of 3.4 / 10. A very small number of studies provided adequate information on subjects' baseline data[1, 2, 3, 4, 5] and only three,[5, 6, 7] used concealed allocation during subject recruitment. None of the studies blinded the therapists administering therapy and just one group of subjects[8] were blinded. There was insufficient blinding of outcome assessment in all but four trials[7, 9, 10, 11] and intention to treat analysis was adequately performed in just one study.[12]

Study characteristics

Studies applied a vast range of icing protocols. Few studies reported the specific goals of cryotherapy, and it is not clear whether cooling was employed for immediate care or for rehabilitative purposes. Appendix 2 summarises the mode, duration and frequency of cryotherapy, the total cryotherapy treatment time (overall dosage), the time cryotherapy was initiated in relation to the injury, and the number of days of treatment, for each included study.

Effectiveness of treatment

A total of twelve treatment comparisons were made. Appendix 3 subgroups the studies according to treatment comparison and provides the sample size, overall

PEDro score and effect size estimates for individual studies [standardised mean differences (SMD) [13] for continuous data or risk ratios (RR) for dichotomous data, each with 95% confidence intervals (95% CI)]. [14]

Ice vs Heat / Contrast bath
A single study[1] found that ice submersion with simultaneous exercises was significantly more effective than heat plus simultaneous exercises, at reducing swelling between 3 and 5 days post ankle sprain.

Ice vs Ice and Electrical Stimulation
A single study[15] compared the effect of ice alone, to ice and simultaneous electrical stimulation after acute ankle sprains. There was no significant difference when comparing ice alone to ice combined with either low or high frequency electrical stimulation in terms of swelling, pain and range of movement (ROM).

Ice vs No ice
A single study[7] compared the effect of an intermittent icing protocol combined with knee exercises, to exercises alone, after minor arthroscopic knee surgery. The application of ice immediately before a rehabilitation program, significantly decreased pain and improved weight bearing status, however there were no significant differences between groups in terms of knee girth and knee ROM, one-week post surgery.

Ice (Continuous) vs Ice (Intermittent)
Using subjects post Carpal Tunnel Release (CTR); Hochberg[12] compared the effect of continuous cryotherapy, to intermittent 20-minute ice applications, over the first three postoperative days. Subjects applying continuous cryotherapy had a significantly greater decrease in pain, and wrist circumference, in comparison to those using cryotherapy intermittently. This was the only study to compare the effectiveness of two different cryotherapy protocols and although it appears that continuous cryotherapy should be the treatment of choice after surgery, the modes of cryotherapy application were not consistent across the two groups.

Ice and Compression vs Ice and Compression
Four studies[6, 16, 17, 18] compared two different methods of applying simultaneous compression and cryotherapy, but few conclusions could be reached. Two studies[17, 18] did not provide adequate information on the mode of cryotherapy, and all failed to specify the duration and frequency of the ice application.

Ice and Compression vs No Ice
There is marginal evidence that a single simultaneous treatment with ice and compression is no more effective than no crotherapy, after an ankle sprain. Laba[4] found that a single application of ice and compression, in addition to standard rehabilitation treatment (ultrasound, mobility and proprioceptive exercises), produced similar levels of swelling and pain immediately post treatment and at discharge, when compared to those receiving standard treatment only. Sloan[11] also found that a single application of simultaneous ice and compression was as effective as no treatment in terms of reducing pain, swelling and ROM post ankle sprain. Similarly, Edwards[10] found that the continuous use of ice and compression had similar benefits to no treatment, in terms of improving pain and ROM, when applied post surgically.

Ice and Compression vs Ice
Only one clinical study has compared ice and compression to ice alone.[19] The combination of treatments appeared to be significantly more effective than ice, in terms of reducing the amount of intramuscular; and oral analagesia administered post ACL reconstruction. These results must be interpreted with caution however as the mode and duration of ice treatment was not controlled for across groups.

Ice and Compression vs Compression
The majority of included studies have tried to disentangle the effects of ice from compression, by comparing a variety of treatment combinations. In four studies it was difficult to compare the efficacy of each modality,[3, 5, 20, 21] as the mode of compression differed between the intervention and control groups. On the contrary, eight studies strictly controlled for the type of compressive bandages used across comparison groups,[2, 6, 8, 10, 21, 22, 23, 24] however only two[22, 24] reported significant differences in favour of ice and compression.
The initial consensus seems to be that the addition of ice to compression is no more effective than compression alone. However, such a conclusion is limited, as in all eight of these studies, post surgical dressings or socks were used to separate the injured area of the body and the cooling device. Such barriers could potentially mitigate the cooling effect of cold compress.

Ice and Compression plus Placebo Injection vs Ice and Compression plus injection vs Placebo injection
Brandsson[9] found that ice and compression plus a placebo injection were significantly more effective than placebo injection alone at reducing postoperative pain. The addition of a pain killing injection to ice and compression therapy significantly improved the analgesic effect further.

Key update messages

1. A large number of articles have been added to our information base regarding the use of ice in the treatment of acute soft tissue injuries.
2. The methodological quality of these studies is generally poor.
3. The majority have not fully considered the pathophysiological basis of cryotherapy, and may not have used it to it's full potential.
4. There is little evidence to suggest that the addition of ice to compression has any significant effect, but this is restricted to treatment of hospital inpatients.
5. Few studies assessed the effectiveness of ice on closed soft tissue injury, and there was no evidence of an optimal mode or duration of treatment.
6. This review provides further evidence that future studies must focus on developing modes, durations and frequencies of ice application, which will optimise cryotherapy during immediate and rehabilitative care.

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Appendix 1

PEDro scoring scale.

1.	Eligibility criteria were specified	**Yes / No**
2.	Subjects were randomly allocated in groups	**1**
3.	Allocation was concealed	**1**
4.	The groups were similar at baseline regarding the most important prognostic indicators	**1**
5.	There was blinding of all subjects	**1**
6.	There was blinding of all therapists who administered the therapy	**1**
7.	There was blinding of all assessors who measured at least one key outcome	**1**
8.	Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups	**1**
9.	All subjects from whom outcome measures were available received the treatment or control condition as allocated or, when this was not the case, data for at least one key outcome was analysed by 'intention to treat'.	**1**
10.	The results between-group statistical comparisons are reported for at least one key outcome measure	**1**
11.	The study provides both point measures and measures of variability for at least one key outcome.	**1**
	Total points	**10**

Appendix 2

Cryotherapy Protocol Employed within Included Studies

Study	Mode	Rx duration (hrs)	No. Rx / day	No. days treated	Total Cryo Time (overall dosage) (hrs)	Time / place of cryotherapy initiation
Cote[1]	Water bath + ex's	0.3	1	3	1	Third day post injury
Michlovitz [15]	Ice pack	0.5	1	3	1.5	1-28 hrs post injury
Lessard[7]	Gel pack + ex's	0.3	4	7	9.3	At home after discharge
Hochberg (a)[12]	Commerical m.	12	1	3	36	Immediately after surgery
Hochberg (b)[12]	Crushed ice	0.3	18	3	18	Immediately after surgery
	Commercial p.					
Healy (a)[16]	Cryocuff	-	-	-	-	Unclear
Healy (b)[16]	Crushed ice	-	-	-	-	Unclear
Schroder (a)[17]	Cryocuff	Continuous	Continuous	14	336	Prior to tourniquet release
Schroder (b)[17]	Ice bags	-	3	-	-	Unclear
Konrath (a)[6]	Commercial m.	-	-	3-5 days post D/C	-	Unclear
Konrath (b)[6]	Crushed ice	-	-	-	-	Unclear
Whitelaw (a)[18]	Cryocuff	-	-	-	-	Unclear
Whitelaw (b)[18]	-	-	-	-	-	Unclear
Laba[4]	Crushed ice	0.3	1	1	0.3	Day 0-2 since injury
Sloan[11]	Commercial pk.	0.5	1	1	0.5	Within 24 hrs of injury
Edwards[10]	Cryocuff	Continuous	Continuous	1.5	36	In operating theatre
Cohn (a)[19]	Commercial m.	Continuous	Continuous	4	96	In operating theatre
Cohn (b) [19]	Ice bag	-	1	1	-	In recovery room
Wilkerson (a)[21]	Ice pack	0.5	1	Acute phase*	1.5	Acute stages*

Wilkerson (b)[21]	Commercial pk	Continuous	Continuous	Acute phase*	64	Acute stages*
Ivey[23]	Commercial m.	Continuous	Continuous	3	64	In recovery room
Scarcella (a)[8]	Commercial m.	Continuous	Continuous	9	216	In operating theatre
Scarcella (b)[8]	Commercial m.	Continuous	Continuous	9	216	In operating theatre
Dervin[2]	Cryocuff	Continuous	Continuous	2.5	55-60	Unclear
Barber[22]	Commercial m. -	Continuous -	Continuous	3 (POD 1-3) 3 (POD 4-6)	64 48 av.	After application of postoperative dressing
Ohkoshi[24]	Commercial m	Continuous	Continuous	2	48	After surgical wound was covered
Bert[20]	Commercial m/pk	Continuous	Continuous	1-2	27	Immediately post surgery in recovery room
Levy[5]	Cryocuff	Continuous	Continuous	3	64	After skin closure and dressing were applied
Gibbons[3]	Cryocuff	6 (at least)	1	13 (at least)	78	Immediately after the surgical procedure
Brandsson[9]	Cryocuff	Continuous	Continuous	1	24	After surgical wounds were closed

Rx duration:	Treatment duration	- :	Information not reported
No. Rx / day:	Number of treatments per day	Commercial m:	Commercial icing machine
No. days Rx:	Number of days of treatment	Commercial p:	Commercially produced ice pack
POD:	Post operative day	I/A:	Minumum temperature of intracondylar notch
*:	'Acute' stage of injury not specified	+ ex's:	Exercises incorporated with cooling (NB. specifically stated by the author)
av :	Average		
D/C:	Discharge		

Appendix 3

Effect size estimates for individual studies.
NB. Studies are grouped according to the treatment comparisons employed.

Intervention	*Injury*	*N*	*Effect Size (95% CI)*				*PEDro* **(10)**
			Function	*Pain*	*Swelling*	*ROM*	
Ice vs Heat	Ankle[1]	30	-	-	1.38 (0.35; 2.29)	-	**5**
Ice vs Contrast	Ankle[1]	30	-	-	2.35 (1.13; 3.37)	-	**5**
Ice vs Ice + E-Stim (Frequency 28 pps)	Ankle[15]	30	-	-0.64 (-1.51; 0.28)	-0.47(-1.34; 0.44)$_{\textbf{Day 1}}$ -0.14 (-1.01; 0.75)$_{\textbf{Day 3}}$	-0.69 (-1.56, 0.24)$_{\textbf{Day 1}}$ -0.58 (-1.45, 0.24)$_{\textbf{Day 3}}$	**4**
Ice vs Ice + E-Stim (Frequency 80 pps)	Ankle[15]	30	-	-0.62 (-1.5; 0.3)	-1.39 (-2.3; 0.36)$_{\textbf{Day 1}}$ -0.09 (-0.96; 0.8)$_{\textbf{Day 3}}$	-1.36(-2.3; -0.3)$_{\textbf{Day 1}}$ -0.39 (-1.3, 0.5)$_{\textbf{Day 3}}$	**4**
Ice + ex vs exercise	Arthros[7]	45	-	0.24 (-0.35; 0.82)$_{\textbf{T}}$ 0.59 (-0.02; 1.17)$_{\textbf{A}}$	0.35 (-0.24; 0.93)	0.38 (-0.21, 0.97)	**5**
Ice (continuous) vs Ice (intermittent)	CTR[12]	48	-	1.09 (0.4; 1.7)	2.2 (1.43; 2.9)	-	**4**
I / C vs I / C	TKA[16]	76	-	N/A	N/A	N/A	**2**
	ACL[17]	44	-	N/A	N/A	N/A	**3**
	ACL[6a]	100	-	N/A	-	N/A	**4**
	Arth[18]	102	-	N/A	N/A	N/A	**1**
I / C vs No Rx	Ankle[4]	30	NA	1.5 (1.24; 1.76) 0.88 (0.62; 1.14)	0.76 (0.5; 1.02)	-	**3**
	Ankle[11]	143	-	NA	NA	NA	**3**
	ACL[10a]	63	-	N/A	-	NA	**4**
I / C vs Ice	ACL[19]	54	N/A	4.43 (3.3; 5.24) 4.49 (3.41; 5.4)	-	-	**4**
I / C vs C (Same Mode)							
	Ankle[21a]	34	-0.14 (-0.97, 0.7)	-	-	-	**3**
	TKA[23]	90	-	-0.43 (-0.95; 0.1)	-	-	**4**
	TKA[8]	24	-0.75 (-1.55, 0.1)	-	-	0.39 (-0.44, 1.18)	**5**

	ACL[6b]	100	NA	NA	-	NA	**4**
	ACL[10b]	63	-	NA	-	NA	**4**
	ACL[2]	78	N/A	-0.33 (-0.7; 0.12)$_{\mathbf{VAS}}$ -0.17 (-0.6; 0.3)$_{\mathbf{A/gesic}}$ -0.09 (-0.5; 0.4)$_{\mathbf{IV}}$	- - -	-	**3**
	ACL[22]	99	-	NA	-	1.14 (1.0; 1.28)	**1**
	ACL[24a]	21	-	-0.6 (-1.64; 0.5)$_{\mathbf{VAS}}$ 0.3 (-0.75; 1.36)$_{\mathbf{A/gesic}}$	- -	1.02 (-0.16; 2.05)	**4**
	ACL[24b]	21	-	1.21 (0; 2.2)$_{\mathbf{VAS}}$	0.89 (-0.26; 1.92)	0.8 (-0.27; 1.9)$_{\mathbf{A/gesic}}$	**4**
	THA[8]	50	-	N/A	-	-	**5**
I/C vs C (Diff Mode)	LRR[20]	110		Overall score: 0.35 (0.27; 0.42)			**2**
	Ankle[21b]	34	0.55 (-0.32, 1.38)	-	-	-	**3**
	TKA[5]	80	- -	0.75 (0.3- 1.2)$_{\mathbf{VAS(D2)}}$ 0.41 (-0.04; 0.85)$_{\mathbf{A/gesic}}$	- -	0.64 (0.19, 1.08)$_{\mathbf{Day7}}$ 0.89 (0.42, 1.34)$_{\mathbf{Day14}}$	**5**
	TKA[3]	60	-	NA	-	NA	**3**
I/C + P. vs P. vs I/C and I/A inj.	ACL[9]	50	-	NA	-	-	**4**

I, Ice treatment
C, Compression
I / C, Simultaneous ice and Compression
I/A inj, Intra articular analgesic injection
P, placebo
E Stim, Electrical Stimulation
Same, Mode of compression constant across groups consumption
Diff, Mode of compression differed across groups score
Ex, exercise

TKA, Total knee arthroplasty
THA, Total hip arthroplasty
ACL, Anterior Cruciate Ligament reconstruction
Arth, Arthroscopy
LRR, Lateral Retinacular Release
CTR, Carpal tunnel release
Ankle, Ankle sprain

- , Outcome not measured
N/A, Data not available
1 –22 , Reference number.
Effect size: Relative Risk ratio.
$_{\mathbf{VAS}}$, Visual analogue scale
$_{\mathbf{A/gesic}}$, Oral analgesic consumption
$_{\mathbf{I/V}}$ Intravenous analgesic
$_{\mathbf{T}}$**:** Total McGill questionnaire
$_{\mathbf{A}}$**:** Affective component McGill questionnaire score

NB. A positive SMD or RR represents an effect in favour of the treatment group (eg. group A if the groups are compared as A vs B).

Appendix 4

Summarising the evidence

Comparison / Treatment strategy	*Conclusions*	*Level of evidence*
Ice vs Thermotherapy / Contrast Therapy[1]	Ice alone is significantly better at minimising swelling	A6
Ice vs Ice and Electrical Stimulation[15]	The addition of electrical stimulation to ice has no significant effect	A6
Ice and Exercise vs Exercise alone[7]	Therapeutic exercise is most effective when combined with ice	A6
Continuous Ice vs Intermittent Ice[12]	Continuous icing is more effective than intermittent ice applications NB. Mode of icing was note consistent across comparison groups	A6
Ice and Compression vs No treatment[4, 10, 11]	Single applications of ice and compression are ineffective	A3
Ice and Compression vs Ice[19]	Ice and compression is more effective than ice alone NB. Mode and duration of ice treatment was not controlled for across groups	A6
Ice and Compression vs Ice and Comp[6, 16, 17, 18]	Limited conclusions 2 studies did not provide adequate information on the mode of cryotherapy All 4 studies failed to specify the duration and frequency of the ice application.	-
Ice and Compression vs Comp[2, 3, 5, 6, 8, 10, 20, 21, 22, 23, 24]	6 studies concluded that the addition of ice to compression has no significant effect 2 studies reported that ice and compression was significantly more effective than compression alone. The remaining 4 studies failed to control for the type of compressive bandages used across comparison groups NB. Potential mitigation of cooling effect of cold compress as in all studies (n=14), post surgical dressings or socks were used to separate the injured area of the body and the cooling device.	A3

A1, evidence from 2 or more large RCT's (n≥60 per study group); **A2**, evidence from at least 1 large RCT (n≥60 per study group); **A3** evidence from 2 or more moderate RCT's (n≥30 per study group); **A4**, evidence from at least 1 moderate RCT (n≥30 per study group); **A5** evidence from 2 or more small RCT's (n≥15 per study group); **A6** evidence from at least 1 small RCT (n≥15 per study group).