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What Is the Evidence for Rest, Ice, Compression, and Elevation Therapy in the Treatment of Ankle Sprains in Adults?

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Context: Ankle sprains are common problems in acute medical care. The variation in treatment observed for the acutely injured lateral ankle ligament complex in the first week after the injury suggests a lack of evidence-based management strategies for this problem.

Objective: To analyze the effectiveness of applying rest, ice, compression, and elevation (RICE) therapy begun within 72 hours after trauma for patients in the initial period after ankle sprain.

Study Selection: Eligible studies were published original randomized or quasi-randomized controlled trials concerning at least 1 of the 4 subtreatments of RICE therapy in the treatment of acute ankle sprains in adults.

Data Sources: MEDLINE, Cochrane Clinical Trial Register, CINAHL, and EMBASE. The lists of references of retrieved publications also were checked manually.

Data Extraction: We extracted relevant data on treatment outcome (pain, swelling, ankle mobility or range of motion, return to sports, return to work, complications, and patient satisfaction) and assessed the quality of included studies. If feasible, the results of comparable studies were pooled using fixed- or random-effects models.

Data Synthesis: After deduction of the overlaps among the different databases, evaluation of the abstracts, and contact with some authors, 24 potentially eligible trials remained. The full texts of these articles were retrieved and thoroughly assessed as described. This resulted in the inclusion of 11 trials involving 868 patients. The main reason for exclusion was that the authors did not describe a well-defined control group without the intervention of interest.

Conclusions: Insufficient evidence is available from randomized controlled trials to determine the relative effectiveness of RICE therapy for acute ankle sprains in adults. Treatment decisions must be made on an individual basis, carefully weighing the relative benefits and risks of each option, and must be based on expert opinions and national guidelines.

Key Words: ankle ligament injury, cryotherapy, bandages

Key Points

- Randomized controlled trials provide insufficient evidence to determine the effectiveness of rest, ice, compression, and elevation (RICE) therapy for acute ankle sprains in adults.
- Treatment decisions must be made on an individual basis, carefully weighing the relative risks and benefits of each option, and must be based on expert opinions and guidelines.
- Sufficiently powered, high-quality, and appropriately reported randomized trials of the different elements of RICE therapy for acute ankle sprains are needed.

Ankle sprains are one of the most prevalent injuries of the musculoskeletal system. Researchers have estimated that 1 ankle sprain occurs per 10 000 people each day.[1] The most common mechanism of injury is inversion of the plantar-flexed foot. Inversion injuries involve about 25% of all injuries of the musculoskeletal system, which affect more than 20 000 patients in the United States each day.[2,3] About 50% of these injuries are sport related[4,5]; some sports (basketball, soccer, and volleyball) have a particularly high incidence of ankle injuries.[6,7] If not treated properly, inversion injuries of the ankle can result in persistent problems in 30% to 40% of patients.[4,8]

The treatment of inversion ankle injuries is provided by emergency and primary health care physicians, athletic trainers, physiotherapists, and orthopaedic and trauma surgeons. Each year, approximately 1 million patients with acute lateral ankle ligament injuries are examined by primary care physicians in the United States.[9] The annual cost to society for ankle injuries has been estimated to be approximately €40 million (US $30.4 million) per 1 million people.[10] Most authors use the term *sprain* to describe a morphologic condition representing a diversity of pathologic conditions, ranging from overstretching of the ligament to complete rupture with gross instability of the joint.[11]

The ankle ligaments are the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), and posterior talofibular ligament (PTFL), and together they form the lateral ligament complex of the ankle.[12] The ATFL is the first or only ligament to sustain injury in 97% of the cases.[13,14] Broström[5] found that combined ruptures of the ATFL and the CFL occurred in 20% of the cases and that isolated rupture of the CFL occurred in only 3%. The PTFL usually is not injured unless a true dislocation of the ankle occurs.[5] Rest, ice, compression, and elevation (RICE) are generally accepted methods for treating inflammation after trauma, such as acute ankle sprain.[15,16] Inflammation causes pain, edema, hyperalgesia, and erythema, all of which can limit the patient's ability to perform the rehabilitation required for proper healing.[17] Gentle tension and stretching at the joint promote proper ligament fiber growth into tight, parallel strands. Accumulation of fluid and edema around an injury site also increases tissue damage, delays healing, and can result in some degree of chronic disability.[18]

According to the Dutch Quality Institute for Healthcare CBO consensus guidelines,[19] RICE therapy is the preferred treatment for the first 4 to 5 days. After this period, the physical examination provides a high-quality assessment.[19–21] The inconsistent outcome of physical examination within 48 hours of trauma is caused by the diffuse character of the pain, the swelling that gives no information about whether it is due to hematoma or edema formation, and the unreliability of the anterior drawer test due to pain and swelling.[19–21]

Rest, ice, compression, and elevation therapy is an accessible and popular modality in the treatment of acute ankle sprains. Therefore, the objective of our study was to analyze the effectiveness of applying RICE therapy begun within 72 hours after trauma for patients in the initial period of ankle sprain. The specific null hypotheses included the following: (1) No differences existed in outcome measurements between using rest, immobilization, or no movement or mobilization and using early mobilization or movement for acute treatment of ankle sprains; (2) No differences existed in outcome measurements between using ice, cold, cold therapy, cryotherapy, or cooling and using no ice, no cold, or heat for acute treatment of ankle sprains; (3) No differences existed in outcome measurements between using compression and using no compression for acute treatment of ankle sprains; and (4) No differences existed in outcome measurements between using elevation and using no elevation for acute treatment of ankle sprains. In addition to other reviews concerning the treatment of acute lateral ankle sprains[22–28] (also G.M.M.J.K., unpublished data, January 2011), our systematic review will be helpful in the further development of evidence-based treatment recommendations and protocols.

METHODS

Definitions

Rest. Rest is required to reduce the metabolic demands of the injured tissue and thus avoid increased blood flow. It also is needed to avoid stress on the injured tissues that might disrupt the fragile fibrin bond, which is the first element of the repair process. Rest can be applied selectively to allow some general activity, but the patient must avoid any activity that induces stress or strain to the injured area and thus can compromise the healing process.[29]

Ice. Ice is the most common means by which cooling is achieved. We use the term *ice* to represent the application of cryotherapy in general, with the different means by which this can be achieved being considered in more detail later. Ice is used to limit the injury-induced damage by reducing the temperature of the tissues at the site of injury and consequently reducing metabolic demand, inducing vasoconstriction, and limiting the bleeding. It also can reduce pain by increasing threshold levels in the free nerve endings and at synapses and by increasing nerve conduction latency to promote analgesia. [29]

Compression. The goal of compression is to stop hemorrhage and reduce swelling. Compression is applied to limit the amount of edema caused by the exudation of fluid from the damaged capillaries into the tissue. Controlling the amount of inflammatory exudate reduces the amount of fibrin and ultimately the production of scar tissue and helps to control the osmotic pressure of the tissue fluid in the injured area. [29]

Elevation. Elevation of the injured part lowers the pressure in local blood vessels and helps to limit the bleeding. It also increases drainage of the inflammatory exudate through the lymph vessels, reducing and limiting edema and its resultant complications. [29]

Literature Search Strategy

Two independent researchers (M.P.J.v.d.B., L.W.) performed a search in the following databases: MEDLINE (from 1966 to July 2010), Cochrane Clinical Trial Register (from 1988 to August 2010), CINAHL (from 1988 to August 2010), and EMBASE (from January 1988 to August 2010) to identify all studies concerning the application of at least 1 of the components of RICE therapy for an acute ankle sprain. The search terms used were *ankle injuries*, *rupture*, *ankle joint*, *lateral ligaments*, *sprains*, *randomized clinical trial*, *random allocation*, *placebo*, *rest*, *immobilization*, *ice*, *cold*, *therapy*, *cryotherapy*, *cooling*, *compression*, and *elevation* (Table 1). References listed in the retrieved publications also were examined manually to identify additional studies. Papers in English were considered for this review, and papers in other languages were considered if translation was available. Abstracts from scientific meetings, unpublished reports, ongoing studies, and review articles were excluded.

Selection Criteria

Types of Studies. The search of the literature was limited to original randomized or quasi-randomized controlled trials concerning at least 1 of the 4 components of RICE therapy in the treatment of acute ankle sprains. Quasi-randomization is a method of allocating participants to a treatment that is not strictly random (eg, date of birth, hospital record number, alternation).

Types of Participants. Inclusion was limited to articles on skeletally mature individuals with an acute (diagnosis within 1 week after trauma) ankle sprain. Trials including children, in whom growth plate injuries predominate, or patients with congenital deformities or degenerative conditions were excluded. A mixed population of adults and children was included if the adult population could be analyzed separately. Patients who had ankle sprains and symptoms of pain and swelling after an inversion trauma were included. A reliable diagnosis of a sprained or ruptured ligament can be made 5 to 7 days after injury.[3,20,21]

Table 1A. PubMed and MEDLINE Search Strategy for Rest

Search Terms: (include use of Clinical Query 'Therapy' en 'Broad, Sensitive'; Limit: 'All Adults')
((((((“ankle injuries”[TIAB] NOT Medline[SB]) OR “ankle injuries”[MeSH Terms] OR ankle injury[Text Word] OR ankle injuries[tw]) OR (“ankle joint”[MeSH Terms] OR ankle joint[Text Word] OR ankle joints[tw]) OR (“lateral ligament, ankle”[MeSH Terms] OR ankle lateral ligament[Text Word] OR ankle lateral ligaments[tw])) OR ((((“sprains and strains”[TIAB] NOT Medline[SB]) OR “sprains and strains”[MeSH Terms] OR sprain[Text Word] OR sprains[tw]) OR (distortion[tw] OR distortions[tw]) OR (“Rupture”[Mesh:noexp] OR rupture[tw] OR ruptures[tw])) AND (“ankle”[MeSH Terms] OR ankle[Text Word] OR ankles[tw]))) AND ((“Restraint, Physical”[Mesh:noexp] OR “physical restraint”[tw]) OR (“Immobilization”[Mesh:noexp] OR immobilizat*[tw]) OR (mobilizat*[tw])) AND ((adult[MeSH])))) AND ((clinical[Title/Abstract] AND trial[Title/Abstract]) OR clinical trials[MeSH Terms] OR clinical trial[Publication Type] OR random*[Title/Abstract] OR random allocation[MeSH Terms] OR therapeutic use[MeSH Subheading]) AND ((adult[MeSH]))

Trials in which the authors focused only on the treatment of chronic ankle instability or postoperative treatment were excluded. Patients with chronic instability have symptoms of pain, swelling, recurrent sprains, and instability for more than 6 months.[30,31]

Types of Intervention. We categorized 4 general components of RICE therapy in the treatment of acute lateral ankle sprains and included trials in which researchers made at least 1 of the following comparisons: (1) immobilization versus mobilization, (2) ice versus no ice, (3) compression versus no compression, and (4) elevation versus no elevation. Treatment had to be initiated within 72 hours after the trauma. The authors had to describe an adequate follow-up of at least 24 hours. Studies concerning brace, tape, elastic bandage, or soft-cast treatment for acute ankle sprains were excluded because these are not treatments used in the first 5 days after the trauma according to the Dutch guidelines.[19]

Types of Outcome Measures. Data were sought for the following: (1) pain (*yes* or *no*; continuous data), (2) swelling (*yes* or *no*; continuous data), (3) ankle mobility or range of motion (ROM) (continuous data), (4) return to sports (*yes* or *no*; time to achieve) (*return to sports* was defined as a return to participating in the previously performed sport at the same level), (5) return to work (*yes* or *no*; time to achieve), (6) complications and side effects (sensory deficit, infection, allergic reaction, hypothermia, stiffness) (*yes* or *no*), and (7) patient satisfaction (interval, continuous, or dichotomous data).

Table 1B. PubMed and MEDLINE Search Strategy for Ice

Search Terms: (include use of Clinical Query 'Therapy' en 'Broad, Sensitive'; Limit: 'All Adults')
((((“ice”[MeSH Terms] OR ice[Text Word]) OR (“cold therapy”[Text Word]) OR (“Cryotherapy”[Mesh:noexp])) AND ((((“ankle injuries”[TIAB] NOT Medline[SB]) OR “ankle injuries”[MeSH Terms] OR ankle injury[Text Word] OR ankle injuries[tw]) OR (“ankle joint”[MeSH Terms] OR ankle joint[Text Word] OR ankle joints[tw]) OR (“lateral ligament, ankle”[MeSH Terms] OR ankle lateral ligament[Text Word] OR ankle lateral ligaments[tw])) OR ((((“sprains and strains”[TIAB] NOT Medline[SB]) OR “sprains and strains”[MeSH Terms] OR sprain[Text Word] OR sprains[tw]) OR (distortion[tw] OR distortions[tw]) OR (“Rupture”[Mesh:noexp] OR rupture[tw] OR ruptures[tw])) AND (“ankle”[MeSH Terms] OR ankle[Text Word] OR ankles[tw]))) AND ((Humans[Mesh]) AND (adult[MeSH])))) AND ((clinical[Title/Abstract] AND trial[Title/Abstract]) OR clinical trials[MeSH Terms] OR clinical trial[Publication Type] OR random*[Title/Abstract] OR random allocation[MeSH Terms] OR therapeutic use[MeSH Subheading]) AND ((Humans[Mesh]) AND (adult[MeSH]))

Table 1C. PubMed and MEDLINE Search Strategy for Compression

Search Terms: (include use of Clinical Query 'Therapy' en 'Broad, Sensitive'; Limit: 'All Adults')
(((compress*) AND ((((“ankle injuries”[TIAB] NOT Medline[SB]) OR “ankle injuries”[MeSH Terms] OR ankle injury[Text Word] OR ankle injuries[tw]) OR (“ankle joint”[MeSH Terms] OR ankle joint[Text Word] OR ankle joints[tw]) OR (“lateral ligament, ankle”[MeSH Terms] OR ankle lateral ligament[Text Word] OR ankle lateral ligaments[tw])) OR ((((“sprains and strains”[TIAB] NOT Medline[SB]) OR “sprains and strains”[MeSH Terms] OR sprain[Text Word] OR sprains[tw]) OR (distortion[tw] OR distortions[tw]) OR (“Rupture”[Mesh:noexp] OR rupture[tw] OR ruptures[tw])) AND (“ankle”[MeSH Terms] OR ankle[Text Word] OR ankles[tw]))) AND ((Humans[Mesh]) AND (adult[MeSH])))) AND ((clinical[Title/Abstract] AND trial[Title/Abstract]) OR clinical trials[MeSH Terms] OR clinical trial[Publication Type] OR random*[Title/Abstract] OR random allocation[MeSH Terms] OR therapeutic use[MeSH Subheading]) AND ((Humans[Mesh]) AND (adult[MeSH]))

Included Studies

Selection of Trials. From the title and abstract, we reviewed the literature searches to identify potentially relevant articles. The full article was retrieved when the title, key words, or abstract revealed insufficient information to determine appropriateness for inclusion. For each selected article, the full article was retrieved for final assessment. All identified studies were assessed independently by 2 reviewers (M.P.J.v.d.B. and L.W.) for inclusion using the criteria described. Disagreements between reviewers were resolved by discussion and with arbitration by a third reviewer (C.N.v.D.) when differences remained.

After deduction of the overlaps among the different databases, evaluation of the abstracts, and contact with some authors, 24 potentially eligible trials remained. The

Table 1D. PubMed and MEDLINE Search Strategy for Elevation

Search Terms: (include use of Clinical Query 'Therapy' en 'Broad, Sensitive'; Limit: 'All Adults')
(((elevat*) AND ((((“ankle injuries”[TIAB] NOT Medline[SB]) OR “ankle injuries”[MeSH Terms] OR ankle injury[Text Word] OR ankle injuries[tw]) OR (“ankle joint”[MeSH Terms] OR ankle joint[Text Word] OR ankle joints[tw]) OR (“lateral ligament, ankle”[MeSH Terms] OR ankle lateral ligament[Text Word] OR ankle lateral ligaments[tw])) OR ((((“sprains and strains”[TIAB] NOT Medline[SB]) OR “sprains and strains”[MeSH Terms] OR sprain[Text Word] OR sprains[tw]) OR (distortion[tw] OR distortions[tw]) OR (“Rupture”[Mesh:noexp] OR rupture[tw] OR ruptures[tw])) AND (“ankle”[MeSH Terms] OR ankle[Text Word] OR ankles[tw]))) AND ((Humans[Mesh]) AND (adult[MeSH])))) AND ((clinical[Title/Abstract] AND trial[Title/Abstract]) OR clinical trials[MeSH Terms] OR clinical trial[Publication Type] OR random*[Title/Abstract] OR random allocation[MeSH Terms] OR therapeutic use[MeSH Subheading]) AND ((Humans[Mesh]) AND (adult[MeSH]))

Table 2. Study Characteristics

Author	Country	Year	No. of Participants (Time Posttrauma)	Intervention
Green et al[35]	Australia	2001	41 (<72 h)	Anteroposterior mobilization
Karlsson et al[31]	Sweden	1996	86 (<24 h)	Immediate weight-bearing and range-of-motion exercises
Brooks et al[1]	United Kingdom	1981	241 (<48 h)	No treatment, physiotherapy, Tubigrip,[a] immobilization
Eisenhart et al[36]	United States	2003	55 (<24 h)	Osteopathic manipulative treatment
Bleakley et al[34]	Ireland	2010	101 (<7 d)	Early exercises and mobilization
Airaksinen et al[41]	Finland	1990	44 (<24 h)	Intermittent pneumatic compression
Sloan et al[37]	United Kingdom	1989	143 (<24 h)	Cooling anklet and elevation
Laba[38]	New Zealand	1989	30 (<24 h)	Ice
Coté et al[39]	United States	1988	30 (<72 h)	Cold, heat, contract
Hocutt et al[40]	United States	1982	37 (<1 h)	Cryotherapy (early and late), heat
Basur et al[33]	United Kingdom	1976	60 (unknown)	Cryotherapy

[a] Molnlycke Health Care, Gothenburg, Sweden.

full texts of these articles were retrieved and thoroughly assessed as described. This resulted in the inclusion of 11 trials involving 868 patients (Tables 2 and 3). The most common reason for exclusion was that the researchers did not describe a well-defined control group without the intervention of interest but described a control group with another form of intervention. The study by Tsang et al[32] was excluded because the follow-up was too short. The publication dates spanned 34 years; Basur et al[33] was the earliest report, and Bleakley et al[34] was the most recent publication. Six studies were performed in Europe, 3 in North America, and 1 each in Australia and New Zealand (Tables 2 and 3).

Different inclusion criteria, durations of treatments, outcome measurements, and timing of outcome measurements among the trials prohibited pooling of the results and statistical comparison among the included trials.

The searches yielded 101 articles for the intervention *rest*. Full texts of 8 articles were retrieved for further analysis, and 5 articles were included in this review.[1,31,35,36] For the intervention *ice*, the searches yielded 28 articles. Full texts of 11 articles were retrieved for further analysis, and 5 articles were included in this review.[33,37–40] The searches yielded 68 articles for the intervention *compression*. Full texts of 5 articles were retrieved for further analysis, and 1 article was included in this review.[41] For the intervention *elevation*, the computerized searches yielded 25 articles. Full text of 1 article was retrieved for further analysis. However, no articles were included in this review concerning the comparison of elevation and no elevation in the treatment of acute ankle sprains.

Data Extraction

The data from the included studies that could be meta-analyzed were extracted by 1 reviewer (M.P.J.v.) using a prepiloted data-extraction tool and were verified by the second reviewer (L.W.). Disagreements were resolved in a consensus meeting or, if necessary, by third-party adjudication (G.M.M.J.K.). Articles were not blinded for author, affiliation, or source.[42–44] If necessary and possible, the authors were contacted for additional information.

Methodologic Quality

Two independent reviewers (P.A.A.S. and L.B.) obtained the full text of all potentially eligible articles for

Table 3. Study Characteristics

Author	Main Outcome Measures	Follow-Up	Conclusion
Green et al[35]	Dorsiflexion, gait analyses, return to activity	Maximum 2 wk	Mobilization improved pain-free ankle dorsiflexion
Karlsson et al[31]	Karlsson score, chronic instability, return to work and sports participation	18 mo	Early functional treatment resulted in shorter sick leave and earlier return to sports participation but had no influence on long-term effects
Brooks et al[1]	Pain (subjective, inversion, plantar flexion), swelling, bruising	Weekly, maximum 4 wk	Mobilization resulted in most rapid return to functional activity
Eisenhart et al[36]	Edema, range of motion, pain	1 wk	Single-session osteopathic manipulative treatment resulted in less swelling and pain
Bleakley et al[34]	Lower Extremity Functional Scale, pain at rest and with activity, swelling, physical activity, Karlsson score	16 wk	Accelerated exercises improved function
Airaksinen et al[41]	Edema, range of motion, pain, subjective discomfort	4 wk	Intermittent pneumatic compression was better in all outcomes
Sloan et al[37]	Edema, range of motion, pain, ability to bear weight, severity of injury	Maximum 2 wk	Cold and compression was not better than placebo
Laba[38]	Edema, pain, rate of recovery	Until full weight bearing	No differences in outcomes
Coté et al[39]	Ankle volume	3 d	No differences
Hocutt et al[40]	Pain on activities, return to activity	13 d	Early cryotherapy resulted in more rapid return to activity than late cryotherapy or heat
Basur et al[33]	Edema, pain, disability, return to activity	14 d	Cryotherapy resulted in improvement of all outcome measures

independent methodologic assessment. Any disagreement was resolved by consensus or third-party adjudication (M.P.J.v.). Articles were not blinded for author, affiliation, or source.[42–44] The assessment was performed using a piloted, participant-specific modification of the generic evaluation tool used by the Cochrane Musculoskeletal Injuries Group.[45] The scoring scheme for the 10 items of internal and external validity covered by this tool is given in Table 4.

Quantitative Analysis

If possible, the results of comparable studies were pooled using fixed- or random-effects models where appropriate. Individual and pooled statistics were reported as relative risks with 95% confidence intervals (CIs) for dichotomous outcomes and weighted mean difference or, where different scales had been used, standardized mean differences and 95% CIs for continuous outcomes measurements. Heterogeneity among trials was analyzed using a χ^2 test. If possible, sensitivity analyses were conducted to assess the effects of excluding the trials in which the quasi-randomization method was used.

Qualitative Analysis

Because the trial results were heterogeneous, the results were analyzed according to best evidence analysis using a rating system with levels of evidence based on the overall quality and the outcomes of the studies used.[46] *Strong evidence* was defined as generally consistent findings in multiple high-quality randomized controlled trials (RCTs). *Moderate evidence* was defined as generally consistent findings in 1 high-quality RCT and 1 or more low-quality RCTs. *Limited evidence* was defined as only 1 RCT (either high or low quality) or generally consistent findings in controlled clinical trials. *No evidence* was defined as no controlled clinical trials or no RCTs.

RESULTS

Rest

Green et al[35] showed that anteroposterior manipulation and RICE resulted in greater improvement in range of movement than the application of RICE alone for all measures taken after each of the treatment sessions ($P < .01$). Greater increases were found in stride speed within the first and third treatment sessions in the RICE and manipulation group than in the RICE-only group ($P < .05$). Karlsson et al[31] reported a shorter sick leave ($P < .05$) and a faster return to sport participation ($P < .05$) after early functional treatment than after conventional treatment at a mean follow-up of 18 months.

Table 4. Quality Assessment

Question	Scoring Scheme
A. Was the assigned treatment adequately concealed before allocation?	2 = Method did not allow disclosure of assignment 1 = Small but possible change of disclosure of assignment or unclear 0 = Quasi-randomized or open list/tables
B. Were the outcomes of patients who withdrew described and included in the analysis (intention to treat)?	2 = Intention to treat analysis based on all cases randomized possible or carried out 1 = States number and reasons for withdrawal but intention to treat analysis not possible 0 = Not mentioned or states number of withdrawal only
C. Were the outcome assessors blinded to treatment status?	2 = Effective action taken to blind assessors 1 = Small or moderate change of unblinding of assessors 0 = Not mentioned or not possible
D. Were the treatment and the control group comparable at entry?	2 = Good comparability of groups or confounding adjusted for in analysis 1 = Confounding small; mentioned but not adjusted for 0 = Large potential for confounding or not discussed
E. Were the participants blind to assignment status after allocation?	2 = Effective action taken to blind participants 1 = Small or moderate change of unblinding participants 0 = Not possible or not mentioned (unless double blind) or possible but not done
F. Were the treatment providers blind to assignment status after allocation?	2 = Effective action taken to blind treatment providers 1 = Small or moderate chance of unblinding of treatment providers 0 = Not possible or not mentioned (unless double blind) or possible but not done
G. Were the care programs other than the trial options identical?	2 = Care programs clearly identical 1 = Clear but trivial differences 0 = Not mentioned or clear and important differences in care programs
H. Were the inclusion and exclusion criteria clearly defined?	2 = Clearly defined 1 = Inadequately defined 0 = Not mentioned
I. Were the outcome measures used clearly defined?	2 = Clearly defined 1 = Inadequately defined 0 = Not mentioned
J. Was the surveillance active and of clinically appropriate duration?	2 = Surveillance is active and the timing of outcome measures is judged optimal 1 = Surveillance is active and the timing of outcome measures is appropriate 0 = The timing of outcome measures is judged inappropriate, timing of outcome measures is inadequate, and surveillance is not active

The methodologic quality and the quality of reporting data were very poor in the trial published by Brooks et al.[1] Based on the data, they concluded that early mobilization with or without physiotherapy offered the most rapid return to functional activity. Patients who had their ankles immobilized required more days missed from work and more visits to a clinic for follow-up.

Eisenhart et al[36] reported that standard treatment (RICE with or without pain medications) and standard treatment with additional osteopathic manipulative treatment led to improvement at 1-week follow-up in patients with unilateral ankle sprains. Range of motion improved more in patients in the osteopathic manipulative treatment study group (–5.25° ± 8.8°) than in the patients in the standard treatment group (–13.5° ± 12.4°) when the injured and uninjured sides were compared ($P = .01$).

Bleakley et al[34,47] showed that the exercise group had better scores than did a standard intervention group on the Lower Extremity Functional Scale ($P = .008$); this finding was significant at both week 1 (baseline-adjusted difference in treatment = 5.28, 98.75% CI = 0.31, 10.26, $P = .008$) and week 2 (baseline-adjusted difference in treatment = 4.92, 98.75% CI = 0.27, 9.57, $P = .008$). Activity level was higher in the exercise group than in the standard intervention group as measured by time spent walking (1.2 hours [95% CI= 0.9, 1.4] and 1.6 hours [95% CI = 1.3, 1.9], respectively), step count (5621 steps [95% CI = 4399, 6843] and 7886 steps [95% CI = 6357, 9416], respectively), and time spent in light-intensity activity (53 minutes [95% CI = 44, 60] and 76 minutes [95% CI = 58, 95], respectively).

Ice

Sloan et al[37] compared a cooling anklet used with 45° of elevation and a dummy anklet used without elevation. The cooling anklet had a skin pressure of 30 mm Hg, produced a skin temperature ranging from 15°C to 29°C, and was worn for 30 minutes each day for 7 days. The authors observed no differences in outcome measures (pain, swelling, ROM, ability to bear weight) after a single application of cold, elevation, and compression in the accident and emergency department when a background therapy of nonsteroidal anti-inflammatory medication was given.

Laba[38] did not show differences in pain, swelling, or ankle function between ice therapy (ice-pack application = 20 minutes) and no ice therapy. Coté et al[39] observed that ankle sprains treated with cold therapy (cold immersion cylinder at 50°F–60°F [10°C–16°C] for 20 minutes 3 times in 5 days) had less edema than those treated with heat therapy (3.3 ± 11.3 mL and 25.3 ± 19.5 mL, respectively) ($P < .05$).

Basur et al[33] showed that cryotherapy (Cryogel [3M, Berkshire, United Kingdom] during 48 hours) and bandaging resulted in faster reduction of edema, pain, and disability in ankle sprains and reduced the period of disability when compared with bandaging alone. However, this study had low methodologic and reporting qualities. These authors did not mention α levels.

Hocutt et al[40] showed that cryotherapy (ice whirlpool at 40°F–50°F [4°C–10°C] for 12 to 20 minutes, 1 to 3 times per day, for 3 days) started within 36 hours after trauma was more effective than heat therapy (heating pad for 15 minutes, 1 to 3 times per day, for a minimum of 3 days) for recovery in terms of pain and return to full activity ($P < .05$). The group using cryotherapy returned to full activity at 13.2 days, and the group using heat therapy returned at 33.3 days.

Compression

Airaksinen et al[41] reported the results of using intermittent pneumatic compression (IPC), which involved alternating between 30 seconds of inflation and 30 seconds of deflation of the device over 30 minutes. The treatment was applied once each day for 5 days. The authors observed differences in edema ($P < .001$), ROM ($P < .001$), pain ($P < .001$), and ankle function ($P < .01$) at 1 and 4 weeks after treatment with IPC and elastic bandage compared with pressure-bandage treatment only.

Methodologic Quality

The methodologic quality assessment comprised 10 items, each with a maximum of 2 points (Table 5). The average quality score was 8. Eight of the 10 selected studies had a minimum score of 4 and a maximum score of 13. The studies published before 1990 had a mean quality score of 7.4, and the studies published after 1990 had a mean quality score of 10.2. The lowest scores probably were mainly due to the lack of reporting instead of the low study quality.[33,40]

DISCUSSION

Our systematic review presents a comprehensive examination of randomized controlled clinical trials concerning the different elements of RICE therapy. We included only 11 studies, and most were studies conducted before 1990 and of low quality. Our conclusions should be interpreted in this light. We discuss the separate elements of RICE therapy.

Rest

Restrictions in ROM after ankle injury are common and often long lasting, with restrictions in posterior talar glide observed for up to 6 months.[48] These restrictions can contribute to the development of chronic ankle instability. Bleakley et al[22] concluded that moderate evidence exists that manual therapy techniques applied in the acute phase of ankle sprains effectively increase ankle dorsiflexion.

van der Wees et al[49] reviewed the effectiveness of exercise therapy and manual mobilization in the treatment of acute ankle sprains and functional ankle instability by conducting a systematic review of RCTs. Most of these studies were not eligible for our review because the authors did not evaluate the interventions within the first 5 to 7 days after trauma. The overall conclusion of van der Wees et al[49] was that exercise therapy likely effectively reduces swelling and decreases time to return to work in the short term and prevents recurrent ankle sprains in the long term. Manual mobilization initially affects dorsiflexion of the ankle. Given only the short-term effect, the clinical relevance of these findings for general physiotherapy practice might be limited but might be useful in high-level athletes.[49]

Table 5. Results of Quality Assessment[a]

Study	A	B	C	D	E	F	G	H	I	J	Total
Green et al[35]	2	0	2	1	0	0	2	2	2	0	11
Karlsson et al[31]	1	0	0	2	0	0	2	2	2	2	11
Brooks et al[1]	1	0	0	0	0	0	1	2	2	0	6
Eisenhart et al[36]	1	0	0	2	0	0	2	2	2	1	10
Airaksinen et al[41]	1	0	0	0	0	0	0	2	2	1	6
Sloan et al[37]	1	0	2	2	0	0	2	2	1	1	11
Laba[38]	2	2	0	0	0	0	2	2	2	0	10
Coté et al[39]	1	2	0	0	0	0	0	1	2	0	6
Basur et al[33]	1	0	0	0	0	0	0	1	1	1	4
Bleakley et al[34]	1	1	2	2	0	0	2	2	2	1	13
Hocutt et al[40]	0	0	0	0	0	0	1	1	1	1	4

[a] Refer to Table 4 for specific questions.

In the best methodologic study included in this review, Bleakley et al[34] concluded that an accelerated exercise protocol during the first week after ankle sprain improved ankle function. However, some limitations existed in performing this study and drawing the conclusions, as described in a letter to the authors.[50]

McCulloch et al[51] compared mobilization with immobilization and concluded that mobilization was more effective for reducing tenderness but produced no difference in ankle function. The use of nonsteroidal anti-inflammatory drugs was a co-intervention in this study. We excluded this study because the treatment duration was 8 days and the first assessment was at 10 days.

Although pooling is not realistic and the methodologic quality is low, a preliminary conclusion can be drawn. All included studies had a similar conclusion: some type of immediate posttraumatic mobilization is beneficial in the treatment of acute ankle sprains.[1,31,34–36]

Ice

Despite its widespread clinical use, the precise physiologic responses to ice application have not been fully elucidated. Moreover, the rationales for its use at different stages of recovery are quite distinct. Using cryotherapy to manage acute soft tissue injury is based largely on anecdotal evidence.[52] In a systematic review, Bleakley et al[53] assessed the evidence base for using cryotherapy in the treatment of acute soft tissue injuries. Although they included 22 trials, the authors concluded that many more high-quality trials were needed to provide evidence-based guidelines for the treatment of acute soft tissue injuries.[53]

Based on the 4 studies included in their systematic review, Hubbard et al[54] concluded that cryotherapy positively affected return to work and sports. Bleakley et al[52] performed a randomized controlled study to compare the effectiveness of 2 different, clinically appropriate cryotherapy protocols for patients with ankle sprains. Because they did not compare these treatments with a no-ice treatment, we did not include this study in our review. They concluded that in accordance with basic science research, the results highlighted that shorter, intermittent applications might enhance the analgesic effect of ice after acute ankle injury. Ice application seems relatively safe and seems to influence ankle function.[14,51,55] Cold application can be used before therapeutic exercise programs without interfering with normal sensory perception and can be used before strenuous exercise without altering agility.[14,55] Palmieri et al[56] reported that a 20-minute cryotherapy treatment applied to the ankle did not alter core temperature. Based on our review, evidence from RCTs to support the use of ice in the treatment of acute ankle sprains is limited.

Compression

Airaksinen et al[41] suggested that a combination of elastic bandaging and IPC is better than elastic bandaging alone. When reviewing the use of a compression bandage for all soft tissue ankle injuries, Pollard and Cronin[57] concluded that little evidence is available to support this type of treatment. Based on their comparison of different modes of compression, they could not make uniform recommendations regarding the type and level of compression.[57]

Based on our review, evidence from RCTs to support the use of compression in the treatment of acute ankle sprains is limited. No information can be provided about the best way, amount, and duration of compression or the position in which the compression treatment is given (recumbent or elevated).[29,41]

Elevation

We did not include the study by Rucinkski et al[24] because they did not examine the intervention of interest but concluded that elevation is the most appropriate of the 3 used treatment protocols if the major therapeutic objective is to minimize edema in the postacute phase of rehabilitation. Based on expert opinions, several guidelines do recommend elevation in the treatment of acute ankle sprains.[19,29] No randomized trials were found and included in this review, so no evidence based on studies with high levels of evidence is available for the effectiveness of elevation.

CONCLUSIONS

Implications for Practice

Insufficient evidence is available from RCTs to determine the relative effectiveness of RICE therapy for acute ankle sprains in adults. Evidence that some type of immediate posttraumatic mobilization is beneficial in the treatment of acute ankle sprains is moderate. Evidence that ice provides no effect in the treatment of acute ankle sprains is limited. Evidence supporting the use of compression in the treatment of acute ankle sprains is limited. No evidence exists to support or reject the use of elevation in the treatment of acute ankle sprains. Treatment decisions must be made on an individual basis, carefully weighing the relative benefits and risks of each option, and must be based on expert opinions and national guidelines.

Implications for Research

Sufficiently powered, high-quality, and appropriately reported randomized trials of the different elements of RICE therapy for acute ankle sprains are needed. Concealed allocation and blinded outcome measurement would improve the quality and validity of future results. The use of well-defined and validated functional outcome measures, including patient-derived quality-of-life measures, is preferable. Finally, the recording of all relevant cost outcomes could be useful. A difficulty with trials in athletic patients is that these patients do not accept the risk of receiving a second-best treatment.

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