Do Current Practices Hasten Recovery of Ankle Sprains?

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2009 EATA Research to Reality Presentation
Boston, MA
Do Current Practices Hasten Recovery?

**What will we cover?**
- Overview of the Problem
- Basic Science Work
- Results of a recent RCT
- Future Direction

**Who is it for?**
- Clinician-Scholars
- Educators
- Students
My thought process on how this all works

Research ←→ Reality

The By-Product of this process is the creation of CLINICIAN-SCHOLARS

New Reality

2009 EATA Research to Reality
What is Evidence-Based Practice?

Best Research

Clinical Experience

Patient Values

2009 Research to Reality
Improved standing of the profession of Athletic Training

Refine our educational programs to support these concepts

Clinician-Scholars

Evidence-Based Practice
Does it?

If so, what interventions are most effective?

How can we optimize the most effective interventions?
It is not “just” an ankle sprain

- Ankle sprains are the most common musculoskeletal injury that occurs in athletics.

- 25% -50% of time loss from athletics is due to ankle sprains.

- Recurrence rates >70% in basketball (Yeung et al, BJSM, 1994).

- 55-72% report residual symptoms 6 months post-injury (Braun, Arch Fam Med, 1999).

- Relationship between ankle sprain history and development of osteoarthritis (Valderrabano et al, AJSM, 2006).

2009 Research to Reality
Systematic Review of Cryotherapy on Return to Play

- 83 relevant clinical trials
- 79 were excluded because they did not include return to play as an outcome
- 4 reviewed studies
  - 2 had a positive RX effect
  - 1 had a positive effect but attributed it to compression
  - 1 showed no difference

All had PEDro Scores of 3 or 4 (1-10)

Hubbard et al. JAT 39(1) 88-94
Human Studies

- Limited evidence that cold controls edema
Summary of Animal Studies

Farry et al. Ice increased swelling but less histology evidence of inflammation

McMaster & Liddle, 30 C was most effective, however, control limbs had the least swelling

Cryotherapy increases swelling after injury!!

Matsen et al. Used water from 5-25 C Treated limbs were more swollen

Jedinsky et al. No treatment effect from ice limbs swelled after ice was removed
Does cryotherapy affect swelling?

Effects of Cold Water Immersion on Edema Formation After Blunt Injury to the Hind Limbs of Rats

Michael G. Dolan, MA, ATC, CSCS; Richard M. Thornton, PhD; Dale R. Fish, PhD, PT; Frank C. Mendel, PhD

Objective: Despite the long history of using cryotherapy to control edema, we found no randomized, controlled studies providing evidence to substantiate this common clinical practice. The purpose of this study was to determine whether cold water immersion affects edema formation following blunt injuries in rats.

Design and Setting: The feet of 16 rats were traumatized after hind limb volumes were determined. Four 30-minute treatments of cold water immersion (12.8°C to 15.8°C, 55°F to 60°F), interspersed with four 30-minute rest periods, began immediately after trauma to one randomly selected hind limb of each rat. The limb remained in a dependent position during all treatments, rest periods, and volumetric measurements.

Subjects: Sixteen anesthetized Zucker Lean rats were used in the study.

Measurements: Limb volumes were measured after each treatment and rest period for a total of 4 hours.

Results: The volume of treated limbs was significantly smaller (p < .05) than the volume of untreated limbs after the first treatment and remained smaller throughout the experiment.

Conclusions: Immersing rat limbs in 12.8°C to 15.8°C (55°F to 60°F) water immediately after blunt injury was effective in curbing edema formation.

Key Words: cryotherapy, swelling, animal model
Results
Mechanically control swelling by increasing the hydrostatic pressure against the capillary wall.

How much compression is enough?

What mode of compression?
Focal Compression
What type of compression works best?

- Compared uniform, focal, and focal+cold compression on 34 subjects
- No difference between groups p<.05
- Calculated effect size would suggest a small effect or little clinical significance

Wilkerson & Horn-Kingery, JOSPT, 1993(17) 240-246
Comparison of 3 Methods of External Support for Management of Acute Lateral Ankle Sprains

Acute Ankle Sprains n=30

- Elastic Wrap & Horseshoe
- Aircast
- Omni Multiphase

None of the three were superior in increasing range of motion, restoring function, or relieving symptoms.

Guskiewicz et. al JAT 34(1) 5-10
Intermittent Compression

- Static or rhythmic air contraction of sleeve
- Affect the pressure gradient of the tissue

Tsang et al. JAT 2003, 38(4) 320-24
Elevation

- Treatment effect is very short or non-existent
- Elevation and intermittent compression effect lasts less than 5 minutes
- Statistical effectiveness vs. Clinical effectiveness

Tsang et al. JAT 2003, 38(4) 320-24
Summary—So Far

- Limited evidence that ice, compression, elevation at typically applied by certified athletic trainers has any meaningful treatment effect
- Time to try something new!
High Voltage Pulsed Current (HVPC)

- Long touted by clinicians as an effective tool in managing pain and edema and thereby hastening recovery
- No evidence that it hastens recovery!!
High Voltage Pulsed Current

- Short Duration Twin Peak Pulse
- Long Interpulse Interval
- 1-2% Duty Cycle
- Minimal Chemical Changes
- Can select + or - Polarity

A cute Management of Athletic Trauma
Cool-Water Immersion and High-Voltage Electric Stimulation Curb Edema Formation in Rats

Michael G. Dolan*; Anna M. Mychaskiw†; Frank C. Mendel‡

*Canisius College, Buffalo, NY; †Athletic Care, Orchard Park, NY; ‡State University of New York at Buffalo, Buffalo, NY

Objective: Although cryotherapy and high-voltage electric stimulation, both alone and in combination, are commonly applied to curb acute edema, little evidence from randomized controlled studies supports these procedures. Our purpose was to examine the effects of cool-water immersion (CWI) at 12.8°C (55°F), cathodal high-voltage pulsed current (CHVPC) at 120 pulses per second and 90% of visible motor threshold, and the combination of CWI and CHVPC (CWI + CHVPC) on edema formation after impact injury to the hind limbs of rats.

Design and Setting: Both feet of 34 rats were traumatized after hind-limb volumes were determined. Animals were randomly assigned to one of 3 groups: CWI (n = 10), CHVPC (n = 10), or CWI + CHVPC (n = 14). One randomly selected hind limb of each rat was exposed to four 30-minute treatments, interspersed with four 30-minute rest periods beginning immediately after posttraumatic limb volumes were determined. Contralateral limbs served as controls. Limbs remained dependent during all treatments, rest periods, and volumetric measurements.

Subjects: We used 34 anesthetized Zucker Lean rats in this study.

Measurements: We measured limb volumes immediately before and after trauma and after each of 4 treatment and rest periods.

Results: Volumes of treated limbs of all 3 experimental groups were smaller (P < .05) than those of untreated limbs. No treatment was more effective than another.

Conclusions: Cool-water immersion, cathodal high-voltage electric stimulation, and simultaneous application of these treatments were effective in curbing edema after blunt injury. Combining CWI and CHVPC was not more effective than either CWI or CHVPC alone.

Key Words: cryotherapy, electrotherapy, swelling, animal model

Funded by NYSATA
What effect does initial treatment have on acute edema formation?

CHVPC → Decrease in Capillary Permeability

Cryotherapy → Decreases Metabolic Activity

Greater RX Effect?
Results

![Graph showing the change in limb volume over time for treated and untreated limbs. The graph illustrates a significant increase in volume over the 240-minute time period, with the treated limb showing a greater increase compared to the untreated limb.](image-url)
Cryotherapy + HVPC had no added treatment effect.
Why no added treatment effect?

Cryotherapy = HVPC

Strong Analgesic Effect
↓ Metabolic Activity
↓ in Blood Flow
Permeability ??

Some Analgesic Effect
None
No Change in Blood Flow
Permeability
Normal State of Capillary Physiology

- Capillary Walls
- Endothelial Cells
- Plasma Proteins
- Tissue Cells
- Lymph Gland
Inflammatory Process

Edema Formation

Endothelial Cells

Tissue Cell

Tissue Cell

Lymph Gland
Proposed Mechanism of Action

Smooth Muscle Actin and Myosin

Capillary Walls

Endothelial Cells

Curb Edema Formation

Tissue Cell

Lymph Gland
Does Polarity Matter?

![Diagram showing polarity with HVPC unit, anode, and cathode]
“Staircase Effect”

Limb Volumes

Trauma 0 30 60 90 120

Time

Control Limbs
RX
REST
Continuous RX
Effects of Cool-Water Immersion and High-Voltage Electric Stimulation for 3 Continuous Hours on Acute Edema in Rats

Michael G. Dolan*; Anna M. Mychaskiw†; Carl G. Mattacola‡;
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Michael G. Dolan, MA, ATC, CSCS, and Frank C. Mendel, PhD, contributed to conception and design; analysis and interpretation of the data; and drafting, critical revision, and final approval of the article. Anna M. Mychaskiw, ATC, contributed to conception and design; acquisition of the data; and drafting, critical revision, and final approval of the article. Carl G. Mattacola, PhD, ATC, contributed to conception and design; analysis and interpretation of the data; and drafting, critical revision, and final approval of the article.

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Objective: Cool-water immersion (CWI) at 12.8°C (55°F), cathodal high-voltage pulsed current (CHVPC) at 120 pulses per second and 90% of visible motor threshold, or the combination of CWI and CHVPC, applied 30 minutes on, 30 minutes off for 4 hours, are known to curb edema formation after blunt trauma to the hind limbs of rats. Our purpose was to examine the effects of extending treatment times to 3 continuous hours after blunt trauma to the hind limbs of rats.

Design and Setting: A randomized, parallel-groups design of 22 subjects was used. Volumes of traumatized limbs, randomly assigned to CWI (n = 7), CHVPC (n = 8), or CWI followed by CHVPC (n = 7) were compared with those of injured but untreated limbs with analysis of variance.

Subjects: Twenty-two anesthetized Zucker lean rats (mass = 293 ± 27 g).

Measurements: We measured limb volumes immediately before and after trauma and every 30 minutes over the 4-hour experiment.

Results: Volumes of treated limbs of all 3 experimental groups were smaller than those of untreated limbs (P < .05). No treatment was more effective than another.

Conclusions: Exposure to either 3 hours of CWI or CHVPC or to 1 hour of CWI followed by 2 hours of CHVPC effectively curbed edema after blunt injury. These results suggest that these common treatments are effective only during application and hint that application should be maintained throughout the period during which edema is forming.

Key Words: cryotherapy, electrotherapy, swelling, inflammation, treatment time, animal model
Methods
Subjects and Methods

- 21 Zucker Lean rats
- Anesthetized by IP injection of Sodium pentobarbital (60mg/kg of body weight)
- Supplemented as needed during the 4-hour experiment
Measurement System
Limb Volume Measurement
Calculating Limb Volume
CHVPC

120 pulses per second at 90% Visible Motor Contraction
Methodology
Effects of Ibuprofen & Electrical Stimulation on Edema Formation following Blunt Trauma to the Hind Limbs of Rats

Michael G. Dolan, MA, ATC, CSCS  
Paul Graves, ATS  
Chika Nakazawa, ATS  
Theresa Delano, ATC  
Alan Hutson, PhD  
Frank C. Mendel, PhD

2004 EATA Funded Research Award
Ibuprofen

- Nonsteroidal anti-inflammatory Drug (NSAID)
- Effectiveness of Ibuprofen on acute swelling has not been investigated
- Seldom used as a first aid treatment
Treated vs. Untreated Limb

![Graph showing the change in limb volume (mL/Kg) over time for treated and untreated limbs. The graph includes a circular area highlighting the data points for a specific time period. The x-axis represents minutes, and the y-axis represents the change in limb volume. The graph compares the untreated limb (dark blue) and the treated limb (pink).]
No Treatment Was Superior

![Graph showing change in limb volume (mL/kg) over time for different treatments. The graph indicates that no treatment was superior in reducing limb volume.]
How can we optimize our treatments?

**Exercise**

- Untreated
- Intermittent
- Continuous

**Return to Play**
Is Amount of Time Treated Related to RX Effect?

- Inflammation 100%
- Cont. HVPC 85%
- HVPC 1%
- Elevation 17%
- Compression 96%
- Cryotherapy 6%

Minutes per day expressed as %
Mode of Delivery

**Traditional Model**
- Treatment started hours or days after injury
- 20-30 minute treatments
- Variety of settings

**New Model**
- Treatment started within minutes of injury
- Continuous Treatment
- Cathodal HVPC at 120 pps at 90% Visible Motor Contraction

**A cute Trauma Management**
Effects of electrical stimulation on pain, edema and return to play following ankle sprains in college and professional athletes

A Multi-Center Clinical Trial

Frank C. Mendel PhD
Michael G. Dolan, MA, ATC
John Marzo, MD
Dale Fish, PhD, PT
Gregory Wilding, PhD

Funded by a grant from The National Football League
How can we apply long term HVPC to Athletes?

A cute Trauma Management
Application of HVPC for Extended Treatment Time
50 College and Professional athletes who sustained a Grade I or II ankle Sprain

Near Continuous HVPC for 72 hours n=28

Near continuous Sham HVPC for 72 hours n=22

OUTCOME MEASURES

Primary Outcome was number of days until fit to play as determined by ATC

Secondary Outcome included self-reported pain and function, swelling and functional testing (Forward and Lateral Hopping)
Days Lost To Injury

Days Lost

HVPC

Grade 1

Grade 2

* p=.0498
How soon should HVPC be applied after injury?

In the perfect study application of HVPC would occur within one hour of injury.

BUT clinical trials are “messy”
In Reality we did not apply HVPC for 6.25 hours.

**INFLAMMATION**

**RICE**

**TIME GAP**

**HVPC**

Significant edema formation occurs during the early stages of injury. Once it forms, time is the only effective intervention.
KEY STUDY EVENTS

Time of Injury
- Self Reported Pain, ADL’s and Athletic Function

Day After Injury
- Pain, Swelling, Interventions applied by AT

Day Stim Ended
- Pain, swelling, Intervention applied by AT
KEY STUDY EVENTS

Day Forward and Lateral Hop Test Offered
- Self Reported Pain, ADL’s and Athletic Function, Swelling, Hop Distance & Interventions

Day Forward and Lateral Hop Test Passed
- Self Reported Pain, ADL’s and Athletic Function, Swelling, Hop Distance & Interventions

Return to Play
- Pain, swelling, Hop distances and interventions applied by AT
Grade 1 & 2 have nearly the same level of pain at TOI.

High Ankle are more serious injuries but have less pain at time of injury.
How many athletes used NSAIDs

![Diagram showing use of NSAIDs over Days for Live and Sham conditions.]
How Do Athletic Trainers Manage Ankle Sprains?

- AT’s completed daily electronic treatment logs that described scheduled rehabilitation session from time of injury until return to play.
- AT were provided a list of possible treatment interventions and could provide “other” treatments in the electronic submission.
Most Common Interventions on day HVPC ended

Interventions

- Isotonics
- Cold Whirlpool
- Functional Exer.
- Running Rehab
- E-Stim
- Theraband
- Proprioception
- Ice pack
- Achilles Stretch
- AROM

% Applied
Daily Treatments on Day Forward Hop Test Passed

Exercise

- Surgical Tubing
- Cold Whirlpool
- Functional Exer.
- E-Stim
- Ice pack
- Isotonics
- Running Rehab
- Theraband
- Proprioception
- AROM
- Achilles Stretch

% Applied
Least Common Interventions at Day Hop Tested Passed

No Athletic Trainers applied these interventions!
Joint Mobilizations

- Fewer Treatments
- Less Pain
- Increase in ROM
- Increase in Stride Length

Forward and Lateral Hop at RTP

% of Uninjured Limb

RANGE =

How useful is functional testing?
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<tr>
<th>Name</th>
<th>Degree(s)</th>
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<tbody>
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- Niagara Univ.
- St. John Fisher
- Univ. at Buffalo
- Univ. at Stony Brook

Clinical Sites for Ankle Trial
Do Current Practices Hasten Recovery?

Cryotherapy
Compression
CHVPC

- Early and Aggressive Application
- Consider Extended Treatment Times
- Initiate Balance and Weight Bearing Activity
Do Current Practices Hasten Recovery?

Where are we today?
- Testimonials
- Education & manufacturer driven
- Uninjured human subjects
- Animal Models
- Athletic Trainers are in perfect position to answer this question

Where do we want to go?
Large Scale Randomized Clinical Trials that examine our treatments and determine our clinical practice

Research to Reality
Thanks and Questions
Do Current Practices Hasten Recovery of Ankle Sprains?

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