New Clinical Perspectives in Edema Management

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2005 EATA Meeting and Clinical Symposium
Early Treatment Speeds Recovery

- Does it?
- If so, which treatments work and which don’t
- Some “therapeutic” interventions probably have no clinical benefit
- Statistical significance vs. clinical meaningfulness
- How can we optimized our clinical treatments
- Bridging the gap between basic science and clinical practice
Ankle Injuries

- Account for 25% of all missed practices and games in high school and college athletics
- Edema Management is a key component in the rehabilitation process
ACUTE TRAUMA MANAGEMENT
The most common clinical practice in sports medicine

- “Put some ice on it”
- Does ice reduce swelling after an ankle sprain?
Cryotherapy

- Reduces blood flow
- Reduce metabolic activity
- Knight suggested the Secondary Injury Model
- Does the reduction in cell metabolism have any meaningful clinical affect on return to play?
- Rippe and Grega suggested that cold therapy decreases permeability of post capillary venules
  Acta Physiol Scand 1978, 103(3) 252-62
Hocutt et al.

Compared Heat and cold on acute ankle sprains

Concluded that cold worked better than heat

Did cold make it better or did heat make it worse??????

No Controls

No Controls
Ankle sprains that were subacute
Randomized into 3 Treatment Groups

Measurement error was greater than treatment effect
No Control Group

All three treatments caused an increase in swelling
Cold was the least
Acute ankle sprains from an emergency room

Applied a single ice treatment for 30 minutes

Evaluated them 7 days later

Not surprisingly, the authors found no treatment effect
Human Studies

- No compelling evidence that cryotherapy controls edema
Animal Studies

- Allow for greater control of variables
- Smaller samples
- Internal Validity is high
- Can have control groups
- Similar physiology
- Commonly used in all medical fields
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
Literature Review

- No scientific evidence that Cryotherapy controls edema formation after acute trauma
- Most of the data suggests that ice increases swelling
Effects of cold water immersion on edema formation following blunt trauma to hind limbs of rats

Michael G. Dolan, MA, ATC, CSCS
Richard M. Thornton, Ph.D.
Dale Fish, Ph.D, PT
Frank C. Mendel, Ph.D

JAT 1997, 32(3) 233-37.
Results
Cryotherapy

- Cryotherapy is effective in curbing edema
- Treatment effect in spite of dependent positioning
- Cool Water 55° Degrees
- Does it positively affect functional outcomes or return to play?
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
Compression

- Mechanically control swelling by increasing the hydrostatic pressure against the capillary wall
- How much compression is enough?
- What mode of compression?
Uniform Compression

- Ace bandage
- Compression sleeve material
- Equal pressure around the limb
- Easy to apply and inexpensive
Focal Compression

- Take advantage of bodies concavities and convexities
- Popular but unproven
- Continual application is probably one reason for its effectiveness
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
Guskiewicz et. al JAT 34(1) 5-10

Acute Ankle Sprains

- Elastic Wrap & Horseshoe
- Aircast
- Omni Multiphase

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

- Probably works but treatment effect is very short
- 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!
Standard of Care

**PRICE**
- Protection
- Rest
- Ice
- Compression
- Elevation

**OTHER RX**
- NSAIDS
- Stim
- Joint Mobilizations
- Contrast Baths
High Voltage Electrical Stimulation

- Long touted by clinicians as an effective tool in managing pain and edema
- Like ICE, limited evidence that it hastens recovery
- Work from our lab has established that some forms of electrical stimulation curb edema formation using animal models in spite of dependent positioning
Characteristics of High Voltage Stimulation

- High Voltage
- Low average current
- Monophasic-Twin Peak
- Duty Cycle less than 1-2%
Effects of cool water immersions and high voltage electrical stimulation on edema formation following blunt trauma to the hind limbs of rats

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Cryotherapy

Decreases Metabolic Activity

Greater Treatment Effect during Acute Edema Formation

Decrease in Capillary Permeability

Cryotherapy

CHVPC
3 Experimental Groups

- Cool Water Immersion at 12.8°C (CWI)
- Cathodal high voltage electrical stimulation at 120 pps and 90% motor threshold (CHVPC)
- CWI + CHVPC
Results
ICE + STIM had no added effect
Electrical Stimulation

- Effective in curbing limb volumes in spite of dependent positioning
- As effective as Cryotherapy?
- How does it work?
Physiology of Microvessel Permeability

- Normally, walls of microvessels are freely permeable to water and dissolved ions and partially permeable to large plasma proteins.
- Histamine dramatically increases permeability so even macromolecules can escape.
- Permeability increases due to gaps between normally abutted endothelial cells.

Diagram showing the components of a microvessel:
- Cytoplasmic vesicle
- Fenestration
- Cleft
- Endothelial cell of capillary wall
- Basal lamina of capillary
- Plasma membrane of tissue cell
- Interstitial fluid
Normal State of Capillary Physiology

Capillary Walls

Plasma Proteins

Endothelial Cells

Tissue Cells

Lymph Gland
Inflammatory Reaction

Capillary Walls

Endothelial Cells

Capillary Walls

Tissue Cell

Tissue Cell

Lymph Gland

Edema Formation
Proposed Mechanism of Action

Smooth Muscle Actin and Myosin

Capillary Walls

Endothelial Cells

Curb Edema Formation

Tissue Cell

Lymph Gland
"Staircase Effect"

Control Limbs

Continuous RX

Trauma

0 30 60 90 120

Time

Limb Volumes
Effects of cool water immersion and high voltage electrical stimulation on edema formation for three continuous hours

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JAT 2003, 38(4) 225-229

Supported by a NYSATA Grant
Effects of Continuous Treatment

![Graph showing changes in limb volume (mL/Kg) over time for untreated and treated conditions. The x-axis represents minutes, and the y-axis represents changes in limb volume. The graph indicates an increase in limb volume over time for both untreated and treated conditions, with the treated condition showing a steeper increase.](image-url)
Application of HVPC via electrode socks
What Doesn’t Curb Edema

- Low Volt Stimulation
- “pumping action”
- Short treatment times probably have no long-term clinical effect
Polarity Matters!!!
Fig 8.—Anodal stimulation failed to curb edema formation.
“Staircase Effect”

What other types of RX can be used for extended times?
Effects of Ibuprofen & Electrical Stimulation on Edema Formation following Blunt Trauma to the Hind Limbs of Rats

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Theresa Delano, ATC
Alan Hutson, PhD
Frank C. Mendel, PhD

2004 EATA Funded Research Award
Ibuprofen

- Nonsteroidal anti-inflammatory Drug (NSAID)
- Treatment of OA and RA
- Available by prescription or OTC
- Effectiveness of Ibuprofen on acute swelling has not been investigated
- Seldom used as a first aid treatment
Greater Treatment Effect during Acute Edema Formation

Inhibits Prostaglandin Cascade

Decrease in Capillary Permeability

Ibuprofen

CHVPC
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
Ibuprofen

- Equivalent of an 800 mg
- Gavage
CHVPC

Anode

Cathode
CHVPC

- 120 pps at 90% visible motor contraction
Trauma

- Trauma induced by dropping a steel rod (85 grams) through a plexi-glass tube from a height of 30 cm.
- Causes edema and not frank bleeding
Treated vs. Untreated Limb

Graph showing change in limb volume (mL/Kg) over time (Minutes) for both Treated and Untreated limbs. The graph indicates a significant difference between the two groups, with the Treated limb showing a more rapid increase in volume over time compared to the Untreated limb.
No Treatment Was Superior
Ibuprofen

- Effective in curbing acute edema formation when ingested immediately after trauma
- May be as effective as traditional therapies
- Increased effectiveness because of mode of delivery & improved compliance
- Broad spectrum of physiological effects
IBUPROFEN + CHVPC

+ = Greater RX Effect
Can these results be replicated in humans?

Price($) and Compliance are the next major considerations

Cool Water Immersions = High Voltage Pulsed Current = Ibuprofen (NSAIDS)
An Animal Model to Determine the Effectiveness of Acute Care on Restoration of Function following Contusions and Sprains

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Measurement of Edema
Measurement of Function
Effects of RICE and NSAIDs on pain, swelling, and time to recovery following knee surgery
A Randomized Clinical Trial

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Surgical Knee Patients

OUTCOME

RICE

RICE + NSAIDS

NSAIDS Alone

Tylenol

Placebo

Exercise

PAIN

SWELLING

FUNCTION
The Big Question

☐ What effect do our “TREATMENTS” have on return to play??

PAIN  ➔  SWELLING

REDUCE AMOUNT OF TIME LOST BECAUSE OF INJURY
Effects of electrical stimulation on pain, edema and return to play following ankle sprains in college and professional athletes

A Multi-Center Randomized Clinical Trial

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John Marzo, MD
Dale Fish, PhD, PT
Gregory Wilding, PhD

Funded by a grant from The National Football League
16 Colleges and professional teams will serve as clinical sites

35 Certified Athletic Trainers will serve as data collectors

132 Grade I & II Ankle Sprains will be randomized into Treatment and Control Groups
Ankle Sprains & HVPC

RX GROUP
Electrode Sock that delivers HVPC on a continual basis
Treat for 3 days with current on all times except when bathing or receiving RX
CONTROL GROUP

Electrode Sock and unit that delivers HVPC

Stimulators have been modified so that they turn on but then shut off after 5 minutes

Look and Feel of Live Stimulators

Credible Placebo
Core Clinical Concepts

C³

Cool Water

Compression

CHVPC
Clinical Concepts

- Whatever you do—do it fast!
  - Treat the injury continuously
  - Cryotherapy for at least 30 minutes
  - Consider extended RX times
- Continuous focal compression
- Continuous CHVPC while inflammation is present
Clinical Concepts

- NSAIDs as a first aid tool? Choice of Physician
- Reapply ice every 1.5 hours for 30-45 minutes or significant movement event
- Joint Mobilizations for pain and movement
Clinical Concepts

- Continue to apply $C^3$ while acute edema is forming and continue until athlete is FWB, and 75% functional
- Based upon the severity of the injury, initiate movement, proprioceptive exercises and closed chain activity ASAP
Core Clinical Concepts

Cool Water
Compression
CHVPC
Graduate and Undergraduate Students

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