What Is Really Known about Post-Exercise Recovery Methods?

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We Train Hard
We Are Competitive
Is There a Better Way to Recover?
What is Recovery?

- A return to a normal state of health, mind, or strength (Oxford Dictionary)

- Bishop et al. (2008) define recovery as the ability to meet or exceed performance in a particular activity.

- Jeffreys (2005) lists factors of recovery:
  - Normalization of physiological functions (e.g. blood pressure, cardiac cycle)
  - Return to homeostasis (resting cell environment)
  - Restoration of energy stores (blood glucose and muscle glycogen)
  - Replenishment of cellular energy enzymes

- Recovery may include an active component (such as a post-workout walk) and/or a passive component (such as a post-workout massage treatment).

I will be focusing on recovery after training and racing
Benefits of Better Recovery

**Adaptation**
- Body to adapt to stress of exercise

**Repletion**
- Repletion of energy stores

**Repair**
- Tissue repair
- Removal of chemical buildup

Better training sessions in the future
Better competitive performance
Conventional Thoughts on Recovery

R I C E
(Rest Ice Compression Elevation)
Recovery Methods
Do These Methods Work?

- Is there any scientific evidence supporting the current recovery methods?
- Is there any benefit to these methods?
- Is there any harm?
What I Want to Propose

The conventional thinking about recovery from exercise, training, and competition is outdated

We need a paradigm shift and more research about what really works
What Will Be Covered

- **Rest?**
  - Rest (passive) vs. active recovery

- **Ice?**
  - Cryotherapy (aka ice baths)

- **Compression?**
  - Compression wear
  - Pneumatic Compression
  - Massage therapy
What Will NOT Be Covered

- Elevation
- Electronic Interventions
- The effect of sleep
- Nutritional interventions
- PRP and injections
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ACTIVE RECOVERY
What is Active Recovery?

- Completing a workout at a low intensity
- Performing an activity outside of one’s usual sport to allow blood movement and a mild increase in HR

**Theoretically helps by:**
- Reducing residual muscle fatigue
- Removal of lactic acid
- Allows a mental break
Physiological Data

Ahmaidi et al. (1996) found active recovery (AR) decreased blood lactate concentration and allowed higher anaerobic power compared to passive recovery (PR)

Passive vs Active Recovery Studies

Studies in other sports:

- Alpine Ski Racers (White et al 2015): 3 minute walk recovery vs passive standing between runs
- Cycling (Lopez et al 2014): Wingate tests with active or passive recovery on ergometer
- Strength training (Lopes et al 2014): Bench press with active vs passive recovery on lactate and power performance

Active recovery promotes faster lactate clearance and better anaerobic efforts in all studies

Limitations

- Studies are all done with the next interval immediately following the active recovery session
- Anaerobic sports
- Long term or competition effects not noted
Passive vs Active Recovery: Any Conclusions?

- Trend that active recovery can help with lactate clearance
- Likely can benefit spurts of anaerobic activity
- Seems to be more beneficial than complete rest between training and before competition (anecdotal evidence)

However a lot of unanswered questions:

- Does active recovery benefit aerobic sports that induce considerable muscle damage? (i.e. a 30 mile training run)
  - Does it help flush out waste products or would it just induce more muscular damage
- What are the long term effects of active recovery? Does it matter?
- What are the long term effects of active recovery (such as a taper) before competition?
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Cryotherapy
What is Cryotherapy?

Application of cooling to skin above muscle to:

- Temporarily reduce muscle temperature
- Stimulate vasoconstriction
- Inhibit pain

Does cryotherapy have a role in recovery?
Cryotherapy: Rat Studies

- Two studies in rats using crush injury:
  - Schaster et al (2007) found reduced intramuscular pressure, reduced adhering granulocytes, reduced tissue damage and myonectosis at 24 hours
  - Takagi et al (2011) found early reduction in muscle degeneration and leukocyte infiltration but detrimental long term effects (2-4 weeks out) leading to delay in muscle generation (delays in cell-induced repair, larger collagen deposits, decreased macrophage activation)

- Other limitations: animal study, crush injury vs overuse, larger human limbs (can only cool to 25°C)

Cryotherapy: Human Studies

- Many studies across different sports:
  - Rugby: no restorative effect for muscle function tests nor on blood markers of muscle damage
  - Cycling: increased anaerobic contribution but not clear on power output
  - Resistance Training: increased work load on subsequent sessions
  - High Intensity Exercise: no difference between cryotherapy and placebo
  - Running: No change in lactate, VO2, or running economy

Weak evidence overall and no clear conclusions
Suggestion of dependence on temperature
The Anti-Ice Movement

- Against the use of ice as a recovery tool for athletes and active people
- The theory: “healing cannot occur without inflammation”
Cryotherapy: Any Conclusions?

- **Benefits:**
  - Short term pain control
  - Short term inflammation control
  - Possible advantage in situations with quick resumption of activity

- **No effect**
  - Many studies suggesting no effect or equal to placebo
  - Not cold enough?
  - Not long enough?
  - Not the right scenario?

- **Potential Harm**
  - Slows the normal regenerative function of the inflammatory reaction
  - Can lead to further injury when numb
  - Can possibly be detrimental to long term muscle recovery

Possible short term benefits, no performance advantage, and suggestion of long-term detriment
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Compression Wear
Compression Gear

- The use of wearable garments to apply compression to specific parts of the body

- Theoretically, this
  - Accelerates blood flow
  - Helps the body get rid of lactic acid and other metabolic wastes
  - Gets more oxygen to your muscles
  - Decreases muscle soreness
  - Speeds recovery
  - Improves subsequent performance

Is there any scientific evidence to support these claims?
Compression Gear

- Many, many studies of variable methodology
- Will present a select few
Physiological Data

- Measured venous pressure measurement via 18 gauge cannula in dorsal vein of foot with and without elastic compression
- Findings: elastic compression does not increase blood flow but does make the veins less compliant
- Theoretically compression shunts more blood through the deep venous system

Elastic Compression in Running Recovery

- Lower lactate with GCS worn during treadmill and ergometer and recovery
  - Point: Lower lactate because kept in muscles or because cleared better?

- Reduction in delayed-onset muscle soreness 24 hours post 10km trail
- Difference in the frequency and location of soreness

- Higher calf tissue oxygenation but no increase in running performance
  - 20 mmHg increased StO2 by 3.3 %

- Less muscle soreness with CS, possible strength improvement, trivial or unclear differences for CK and IL-6

Overall: Reduction in DOMs, possible increase in tissue oxygenation and decrease in lactate, but no benefit to performance.
Elastic Compression in Other Sports

- **Cycling**
  - Less decrease in max power, lower lactate, lower pain sensation
  - 10/12 thought increased performance, but no measured performance gain

- **Netball/Basketball**
  - No difference CK, LDH, thigh girth, perceived soreness, and no difference in test performance.
  - Women: CS attenuated CK at 24 hours and the perception of muscle soreness

- **Strength Exercise:**
  - The EC30 stockings produced the lowest levels of fatigue

No performance gains but possible decreased muscle soreness and decreased fatigue
Questions about effect of gender and level of compression
Compression: Any Conclusions?

- Does the use of wearable garments to apply compression to specific parts of the body have any benefit?
- Does NOT accelerate blood flow (O’Donnel et al)
- May help the body get rid of lactic acid and other metabolic wastes (Berry et al., Davies for women)
- May show some oxygenation benefit (Menetrier)

Decreases muscle soreness
NO evidence that it speeds recovery or improves subsequent performance
Compression: Any Conclusions?

- **Benefits:**
  - Reduction in delayed muscle soreness
  - Reduction in perceived soreness
  - Possible decreased lactate

- **Questionable:**
  - No clear evidence for attenuation of other markers of muscle damage (CK, IL-6)
  - No clear performance benefit

- **Potential Harm:**
  - No real harm measured or discussed

- **Considerations:**
  - Small group sizes 9-28
  - Effect of bias
  - Mostly male – is there a gender difference?
  - Compression vs Graduated compression?
  - Calf compression vs thigh vs whole body compression?
  - Specificity of effect? (ex. Bieuzen et al.)
  - Does level of compression matter? (Miyamoto et al)
  - Actual pressure on subjects is not always measured
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Pneumatic Compression
Pneumatic Compression

- An inflatable garment for the arm, leg, trunk, or chest that fills with air and intermittently inflates and deflates to provide cyclic compression

- Thought to:
  - Increase venous return
  - Increase lymphatic return
  - Alleviate soreness
  - Improve function of fatigued muscles
  - Help accelerate training
  - Help improve performance

Is there any data behind pneumatic compression?
Hospital SCDs and Physiological Data

- Sequential compression devices (SCDs) = origin of pneumatic compression
- Hospital use: venous stasis, post-operative cases, and lymphedema.

- Pneumatic compression at intermediate setting increases:
  - Venous velocity
  - Muscle blood flow
  - Subcutaneous mean tissue flow

- Highest setting decreased venous velocity and subcutaneous tissue flow and did and did not further increase muscle blood flow

Pneumatic Compression: Exercise Studies

- Only 2 studies outside of the hospital setting!

- Eccentric exercise (single leg jumps) followed by 30 min of Normatec
  - No difference in total work completed, dynamometry measures, CK values

- Eccentric exercise (hand weights) followed by pneumatic compression
  - Decreased circumference and stiffness, especially day 2 and 3
  - Strength was not affected

Pneumatic compression offers no advantage for work completed dynamometry, blood values or strength but may help with stiffness and swelling.
Pneumatic Compression: Any Conclusions?

- Very little data

- Benefits:
  - Increased blood flow
  - Decrease circumference – less swelling?
  - Decrease stiffness

- No data or evidence:
  - Alleviate impaired muscle function
  - Help accelerate training
  - Help improve performance

- Questions:
  - Effect on endurance exercise, sports, competition
  - Ideal pulse pressure and pulse time
  - Sequencing of compression (peristaltic vs sequential)
  - Will it help one recover faster and compete sooner?
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Massage
Massage

- Massage is the pressing, rubbing, and manipulation of muscles and joints with the hands

- Thought to:
  - Improve circulation
  - Reduce stress
  - Decrease muscular pain
  - Enhance lymphatic flow
  - Aid in recovery from exercise and competition
  - Enhance sports performance
Massage: Physiological Effects

- **Blood Flow**
  - No difference in peak torques up to 96 hours post, no difference in arterial or venous blood velocity (doppler US), reduced level of DOMS

- **Lactate**
  - Less forearm blood flow and impaired lactate and H+ removal from muscle with massage

- **Proprioception**
  - EMG: increased activation of gastrocnemius, increased proprioception as measured with ankle joint, not knee joint
  - No significant change in lactate
    - Shin MS1, Sung YH. Effects of massage on muscular strength and proprioception after exercise-induced muscle damage. J Strength Cond Res. 2014 Sep 15. [Epub ahead of print]

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No benefit in blood flow, lactate clearance, or strength but increases in muscle activation, proprioception and reduction in DOMS
Massage: Greatest benefit for DOMS

- Delayed onset muscle soreness
  - No differences in peak torque, ROM, neutrophils, unpleasantness of soreness and mood. However, lower intensity of soreness with massage at 48h.

- Replicated in other studies
  - Farr et al.: Massage after downhill walking reduced soreness at 24 hours
  - Zainuddin et al. 30% reduction in DOMS and reduced swelling with arm flexion exercise, but no difference in strength
 Massage: Performance Recovery

- **Cycling Performance:**
  - No difference in maximum power, mean power, or lactate
  - Lower fatigue index
Massage: Performance Recovery

- **Running Performance:**
  - No change of muscle strength loss, swelling, or soreness
  - Subjective findings of decreased pain and soreness in massaged leg

- **Potential Harm**
  - Underwater jet massage vs control over a one week period
  - Findings: Serum myoglobin increased more than during control week

No benefit of power, strength, or performance but decreased fatigue and soreness

Question of possible muscle damage?
Massage: Any Conclusions?

- Benefits:
  - Alleviate muscle soreness
  - Reduce muscular stiffness
  - Improve perception of recovery

- Questionable:
  - Benefit to muscle function
  - Benefit to recovery

- Potential Harm:
  - Immediately after: may induce harm
  - Create muscle damage?

- Other considerations:
  - What is the optimal timing?
  - What is the best type of massage?
  - What duration?
  - Methodical flaws: standardization of prior exercise, influence of diet
Conventional Thoughts on Recovery

RICE

(Rest Ice Compression Elevation)
Do These Methods Work?

- Is there any scientific evidence supporting the current recovery methods?
- Is there any benefit to these methods?
- Is there any harm?
Is there any scientific evidence supporting the current recovery methods?

- There is some research on all methods

- However:
  - Small group sizes
  - Variations in methodology
  - Potential confounding factors

- Unknown effect of:
  - Bias
  - Gender
  - Age
  - Timing
  - Duration
Is there any benefit to these methods?

- **Active recovery**
  - Spurts of anaerobic activity
  - Lactate clearance

- **Cryotherapy**
  - Short term pain and inflammation control
  - Situations requiring quick resumption of activity

- **Elastic Compression**
  - Reduction in perceived soreness

- **Pneumatic Compression**
  - Increased blood flow
  - Decreased circumference
  - Decreased stiffness

- **Massage therapy**
  - Decreased muscle soreness
  - Improved perception of recovery

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No method has shown a clear benefit to training or performance!
Is there any harm?

- Active recovery
  - Potential for further muscle damage?
- Cryotherapy
  - Potential slowing of normal regenerative inflammatory reaction
  - Potential further injury
  - Potential detriment to long term muscle recovery
- Elastic Compression
  - Question of slowed waste removal
- Pneumatic compression
  - Very little current evidence- potentially not measured?
- Massage
  - Potential to create more muscle damage if done too soon?

Most evidence for damage with cryotherapy, questionable in active recovery or massage
General Conclusions

- The area of recovery is still young and there is so much more to learn.

- Recover method of choice may depend on:
  - Activity type
  - Activity duration
  - Age
  - Sex
  - Timing
  - Individual factors
Our Study

- How can ultrarunners recover faster to be able to compete sooner and better in subsequent races?
- First study post ultramarathon recovery study
- Goal: 80 participants
- Requirements:
  - WSER 2015 runner
  - Willing to participate in either massage vs pneumatic compression vs control with no other post-race recovery modalities
  - Subjective scores: pre and post race log of subjective soreness and fatigue
  - Functional measures: 2 pre-race timed 400 meter runs, 2 post-race
  - CK measure
- Receive “race rat” T-shirt on sign up and WSER jacket on completion and
- Help contribute to science and exercise medicine
- Interested? Contact me, Natalie Wu : nbadowski@gmail.com
Thank You!

Any Questions?
References

(in order of appearance in presentation)


References


References


- Shin MS1, Sung YH. Effects of massage on muscular strength and proprioception after exercise-induced muscle damage. J Strength Cond Res. 2014 Sep 15. [Epub ahead of print]


