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7th ASPC forum
International Forum on Elite Sport
28th august to 1st september 2011
INSEP, Paris

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7th ASPC Forum
INSEP, Paris - August 31th, 2011

CRYOTHERAPY and SPORT

WHOLE-BODY CRYOSTIMULATION (WBC) and the EFFECTS on RECOVERY FROM EXERCISE-INDUCED MUSCLE DAMAGE: EVOLUTION OR REVOLUTION?

CHRISTOPHE HAUSSWIRTH, PHD
RECOVERY & NUTRITION « GUIDELINES »,

coll. JR. Filliard, J. Fournier, H. Pournot & F. Bieuzen
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INTRODUCTION

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Traumatizing sports:
Repetitions of muscular constraints +++ (physio, biomeca, mental)

Muscle damage from eccentric loading (Gandevia, 2001)

Acute Fatigue and muscle soreness (DOMS) (Selwood et al. 2007)

Extrusion of muscular enzymes (e.g. Creatine Kinase, CK) (Selwood et al. 2007)

Alteration of « performance » (Decrease of muscle force generation) (Schwane, 1983)

Post-exercice recovery= Signature of adaptations

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INTRODUCTION

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The recovery

Methods to speed-up the recovery

- Dietary carbohydrate = central component post-exercice nutrition (Hausswirth et al. 2010)
- Electrostimulation (Martin et al. 2004)
- Compression garments (Duffield et al. 2008)
- Stretching (Thacker et al. 2004)
- Massages (Weerapong et al. 2005)
- Cold exposures (4 à 16°C) (Peiffer et al. 2009)

More recently…

OPEN ACCESS Freely available online

PLoS one

Time-Course of Changes in Inflammatory Response after Whole-Body Cryotherapy Multi Exposures following Severe Exercise

Hervé Pournot[1,2], François Bieuzen[1]*, Julien Louis[2], Jean-Robert Fillard[3], Etienne Barbiche[4], Christophe Hausswirth[1]

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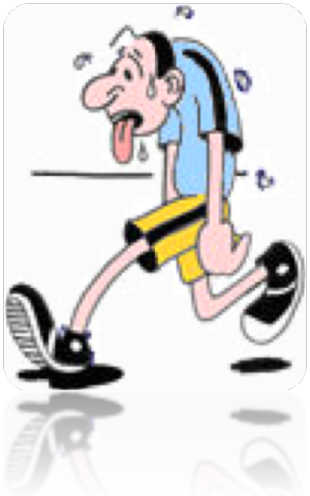
Why improving Recovery?



- ✓ Speed-up adaptations to training loads
- ✓ Decrease risks of overload
- ✓ Reduction in sport injuries
- ✓ Improving the repetition of performances

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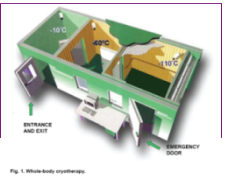

WBC AND INFLAMMATION: RUGBY PLAYERS

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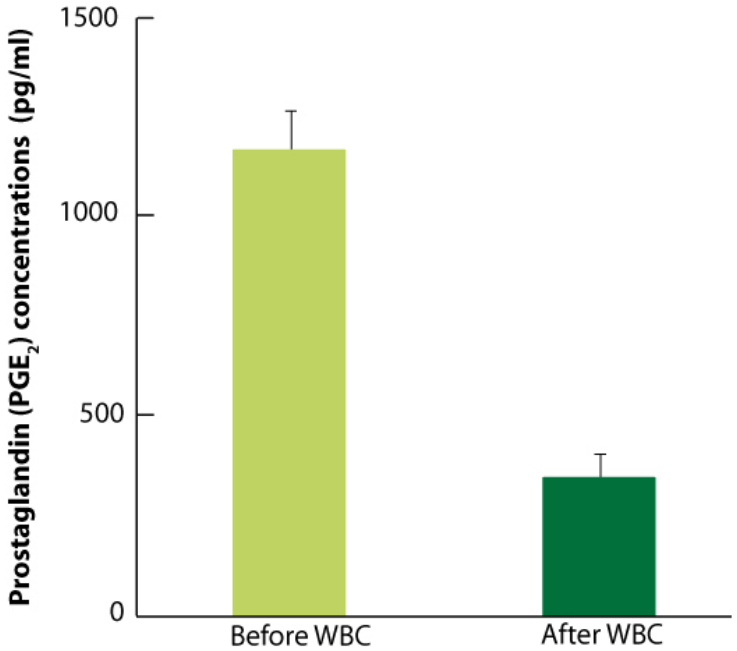

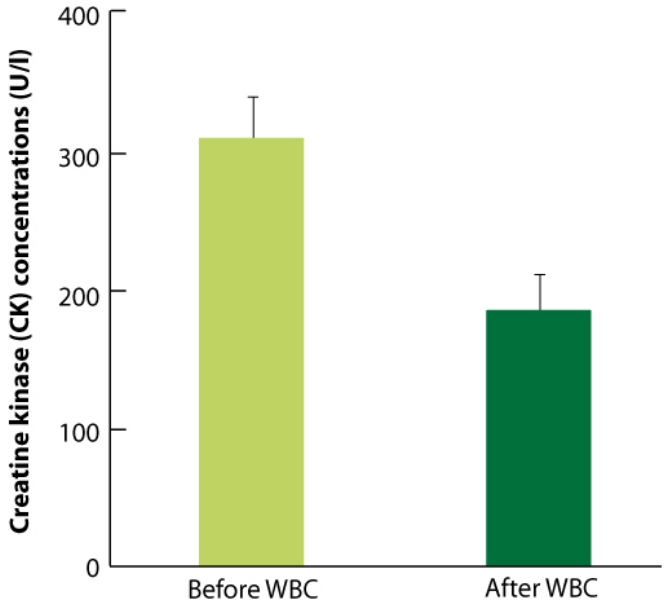

Adapted from Banfi *et al.* (2008a) with permission from the *Journal of Thermal Biology.*

Figure -Variation in serum concentrations of muscle injury markers (prostaglandin and creatine kinase). The left panel shows a significant reduction in prostaglandin PGE_2 ($P < 0.0001$) "After WBC". The right panel shows a significant reduction in creatine kinase ($P < 0.01$) "After WBC".

After 5 sessions of WBC, decrease of PGE_2.
(+ dim. IL-2 et IL-8, aug. IL-10)

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HORMONAL RESPONSES

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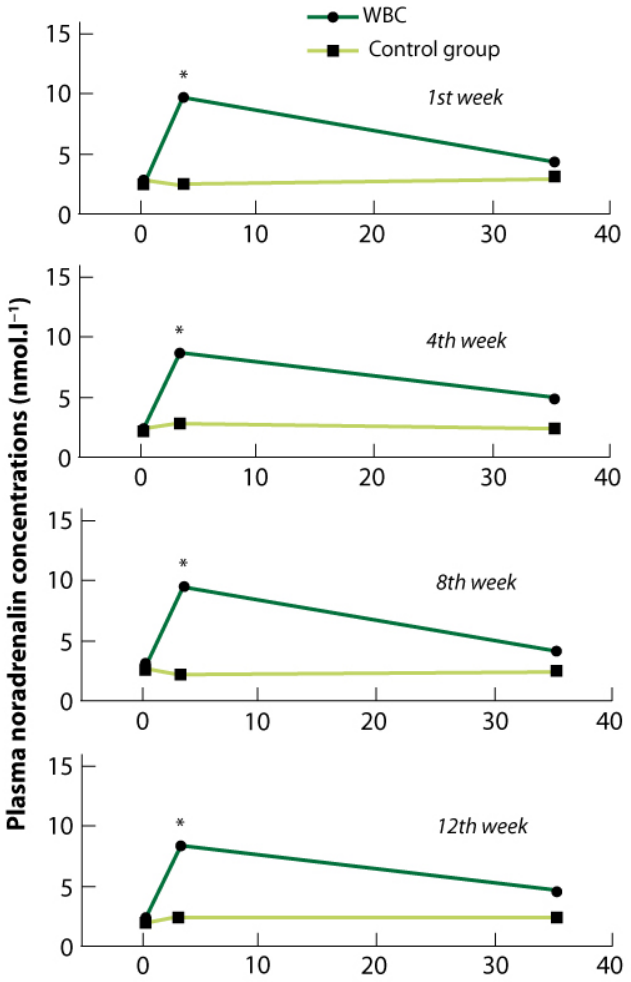
- Plasma ACTH, cortisol and epinephrin were unchanged.
- Exposure to WBC (three times per week for twelve weeks) induced a significant increase in plasma norepinephrin levels
- The authors explains that it could play a role in relieving perceived pain, an effect seen in other studies using traumatising exercise.



*: Significant difference from initial value (P < 0.01).
Adapted from Leppäluoto *et al.* (2008) with permission from *The Scandinavian Journal of Clinical and Laboratory Investigation.*

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OXYDATIF STRESS?

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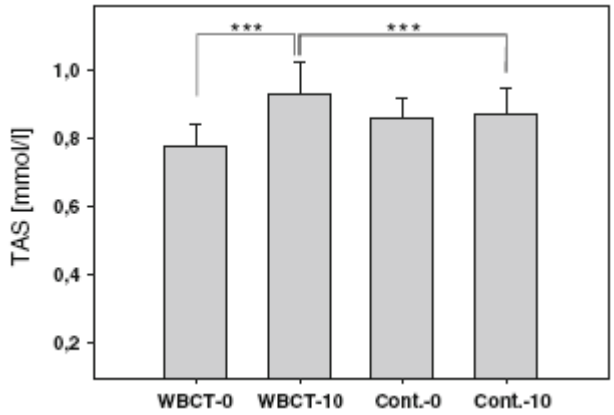
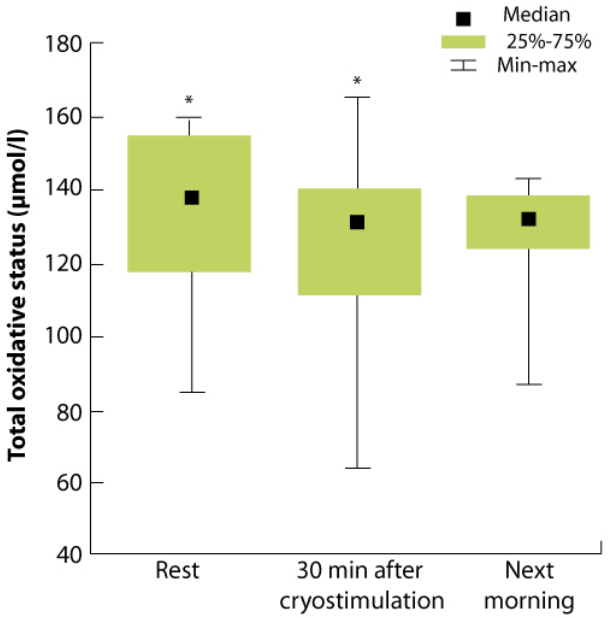
- **Increase in the Total anti-oxidant statut in elite athletes**
- **No differences between males and females in TAS**



Miller et al. EJAP 2011



*: Significant difference between "30 min after cryostimulation" and "Next morning" ($P < 0.05$). Adapted from Lubkowska et al. (2008) with permission from the *Journal of Thermal Biology*.

Figure . Variations in plasma total oxidant status in resting subjects, 30 minutes after cryostimulation and the next morning.

WBC: POSITIVE EFFECTS ON DEPRESSIVE SYMPTOMS

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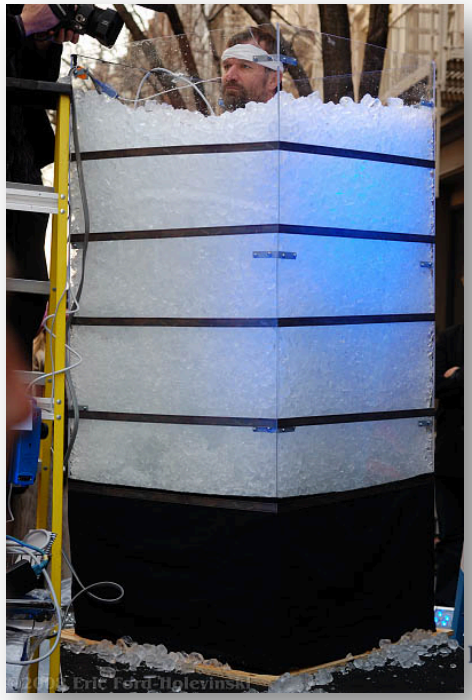

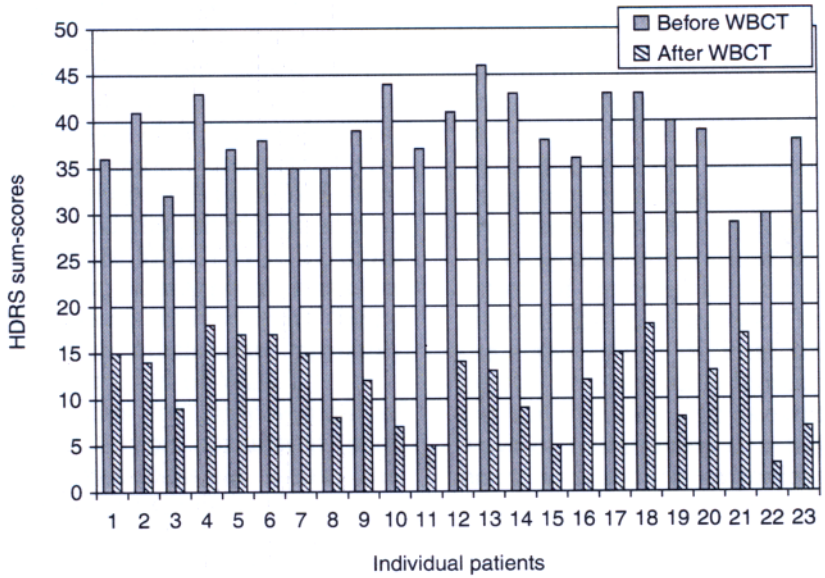

HDRS sum-scores for each individual patient as assessed before the first WBCT procedure and shortly after the last one

D'après Rymaszewska et al. 2003

- 23 people
- Depression using using 21 items (HDRS)
- 2 x 5 exposures of 160 sec, during 2 weeks
- WBC alleviated depressive symptoms

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STUDY ON RECOVERY USING WBC EXPOSURES

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Whole-body Cryotherapy (WBC: 3min at -110°C)

Far Infrared (FIR: 30min at 45°C)

Passive recovery (30min seating in a resting chair)

Markers of EIMD: (48h)

- Maximal Voluntary Contraction(MVC) – knee extension
- Plasma creatine kinase
- Perceived fatigue (general fatigue, Muscle soreness, wellness..)

Hausswirth et al. 2011, PlosOne, *under review*

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RESULTS

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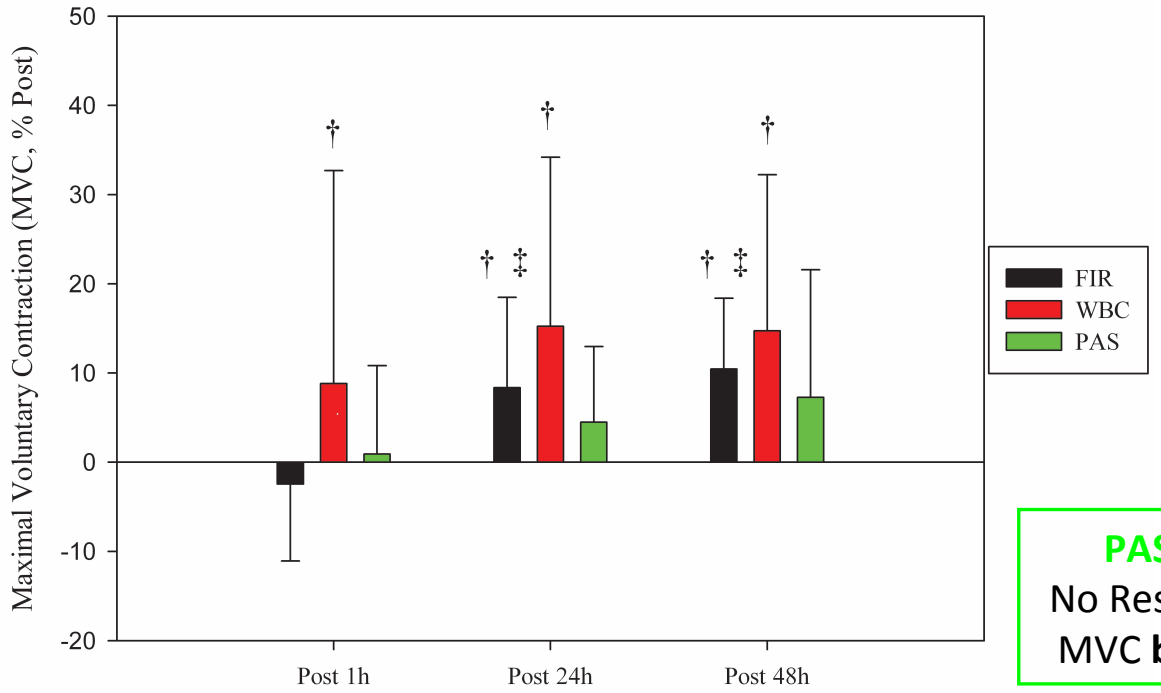
Maximal Voluntary Contraction during knee extension



WBC group:
Restoration in MVC **Post 1h**

FIR group:
Restoration in MVC **Post 24h**

PAS group:
No Restoration in MVC **before 48h**

Pre-post:
Decrease in MVC (-9,6%)

Recovery of knee extensor's maximal voluntary contraction (MVC, % of post), assessed after each of the three recovery sessions (post 1h, post 24h, post 48h).
† significantly different from post condition, ‡ significantly different from post 1h condition ($p<0.05$)

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RESULTS

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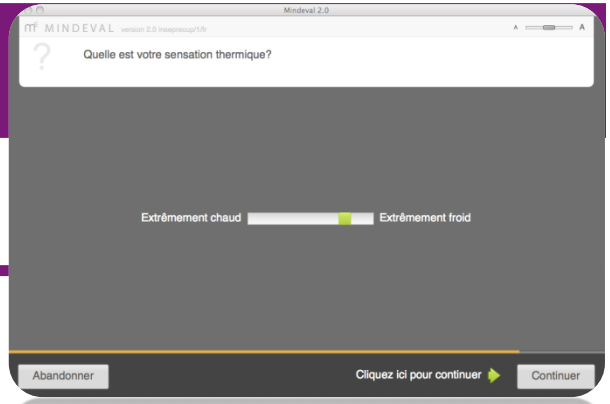

Variables (units)	Pre	Post	Post 1h	Post 24h	Post 48h
CK (% of pre)					
FIR	0.0 ± 0.0	40.5 ± 18.4*	44.2 ± 20.9*	192.3 ± 179.3*†‡	107.5 ± 121.1*$
WBC	0.0 ± 0.0	58.2 ± 18.9*	73.9 ± 33.4*	318.9 ± 224.7*†‡	195.3 ± 141.6*$
PAS	0.0 ± 0.0	56.4 ± 25.1*	63.7 ± 26.5*	231.8 ± 132.1*†‡	137.6 ± 99.8*$
Pain (/100)					
FIR	1.6 ± 3.2	61.9 ± 19.0*	58.3 ± 18.4*	49.3 ± 29.1*	45.2 ± 29.1*†
WBC	0.2 ± 0.7	60.6 ± 20.7*	31.7 ± 23.8*†	33.3 ± 26.1*†	39.0 ± 24.0*†
PAS	0.1 ± 0.3	55.7 ± 18.2*	44.3 ± 23.7*	53.9 ± 25.5*	58.9 ± 19.0*
Tiredness (/100)					
FIR	8.3 ± 9.8	75.3 ± 11.2*	67.8 ± 21.3*	65.8 ± 20.0*	61.8 ± 15.9*
WBC	5.2 ± 9.8	77.9 ± 13.3*	44.6 ± 26.3*†	35.9 ± 19.4*†	46.6 ± 24.0*†
PAS	8.7 ± 12.3	65.4 ± 26.6*	52.2 ± 27.0*	49.2 ± 21.4*	60.7 ± 26.7*
Well-being (/100)					
FIR	86.8 ± 16.9	56.6 ± 31.9*	67.9 ± 28.2*	66.9 ± 27.6*	72.4 ± 19.2†
WBC	77.7 ± 25.2	65.4 ± 26.6	74.9 ± 26.7	87.1 ± 0.0†	81.2 ± 20.4†
PAS	93.9 ± 9.0	58.4 ± 26.8*	69.8 ± 25.3*	65.4 ± 21.1*	68.7 ± 28.1*

Peak of CK post 24h (no recovery effect)

Pain's scores decreased using **WBC (post 1h, 24h and 48h)** and 48h after FIR modality

Subjective Fatigue decreased using **WBC (post 1h, 24h and 48h)**

Well-being increased after **WBC from 24h to 48h**, and after 48h after FIR modality.

* significantly different from pre condition (p<0.05)
† significantly different from post condition (p<0.05)
‡ significantly different from post 1h condition (p<0.05)
$ significantly different from post 24h condition (p<0.05)

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SUMMARY

Whole-body Cryostimulation for recovery can….

- Maintain force generation following severe exercise:
  - ↳ Increasing the anti-inflammatory cytokines
  - ↳ without however changes in many blood markers of damage (CK, TNF alpha) but with a steady-state of the CRP
- Improve perceptual recovery following severe exercise:
  - ↳ better well-being, less DOMS, less tiredness
- Increase moderate - rather than large - improvements…..

may also be an additive effect? Combined recoveries?

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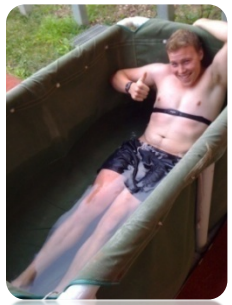
PRACTICAL APPLICATIONS

- Cold therapy as a recovery intervention seems appropriate
- Benefits better when stimulus is larger (*i.e.* heat, damage)
- Beneficial for 'performance', unsure about adaptation?
- Periodise and schedule use of cooling for recovery

  Leave out when adaptation, use for performance…useful for depressive symptoms after a competition



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THANK YOU FOR YOUR ATTENTION

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CRYOTHERAPY and SPORT

Effects of local cryotherapy on muscle recovery subsequent to strenuous eccentric exercise

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BACKGROUND

- Mecanisms of recovery following intense muscular exercises
- Restart or changes of training
  ➡ Delayed Muscle Onset Soreness
- Persistent muscle deficits after the painful phase
- Muscle weakness often underestimated when the pain disappears

Risk of injury

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PURPOSES

To identify the prolonged kinetic of muscle recovery of various mechanical and physiological parameters following strenuous eccentric exercise

To study the effects of local air pulsed cryostimulation on each of these factors

To suggest few recommendations for use of cryotherapy

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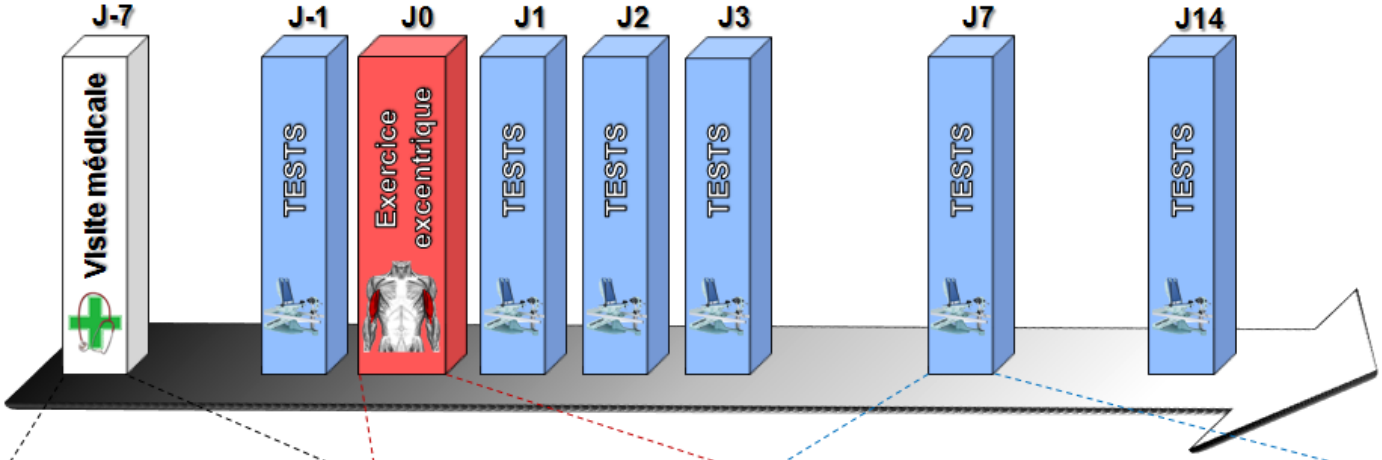
DESIGN



Visite médicale (J-7)

1. Questionnaire médical
2. ECG de repos
3. Examen échographique
4. Familiarisation à l'ergomètre et à l'électrostimulation
5. Test de force isométrique maximale à 90°

Exercice excentrique (J0)

1. Échauffement
2. 3 x 20 contractions excentriques maximales des fléchisseurs de l'avant-bras
3. Amplitude = 120° (60 à 180°)
4. Vitesse angulaire =120°.s^{-1}
5. Repos entre les séries = 3'

TESTS (J-1 à J14)

1. Évaluation de la douleur
2. Prélèvement sanguin
3. IRM
4. Test de force isométrique maximale à 90° (EMG)
5. Onde M
6. Temps limite
7. Onde M
8. **Séance de récupération:**
   - cryothérapie locale à -30°C
   ou
   - passif (groupe contrôle)

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DESIGN

- 12 CONTROL subjects
- 12 **CRYOTHERAPY subjects**
- Eccentric exercise: 3 x 20 reps at 120°.s^{-1}

- Cryostimulation: 3 x 4 min at D0, D1, D2 and D3

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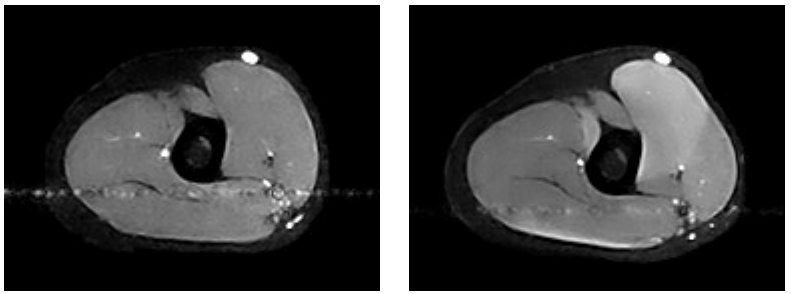
DESIGN

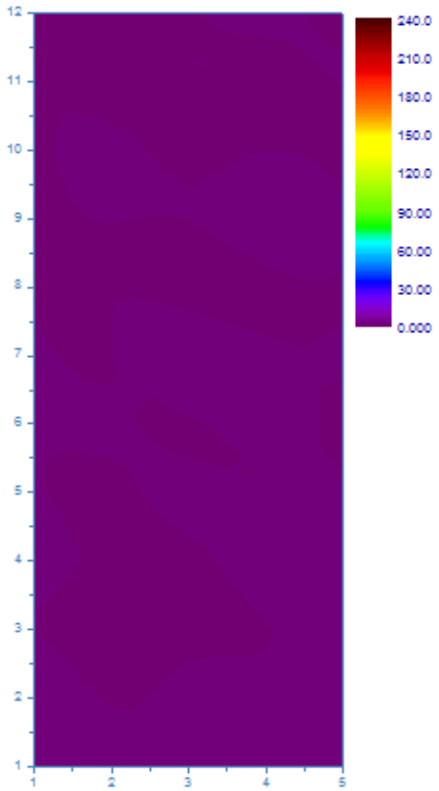
Magnetic Resonance Imaging

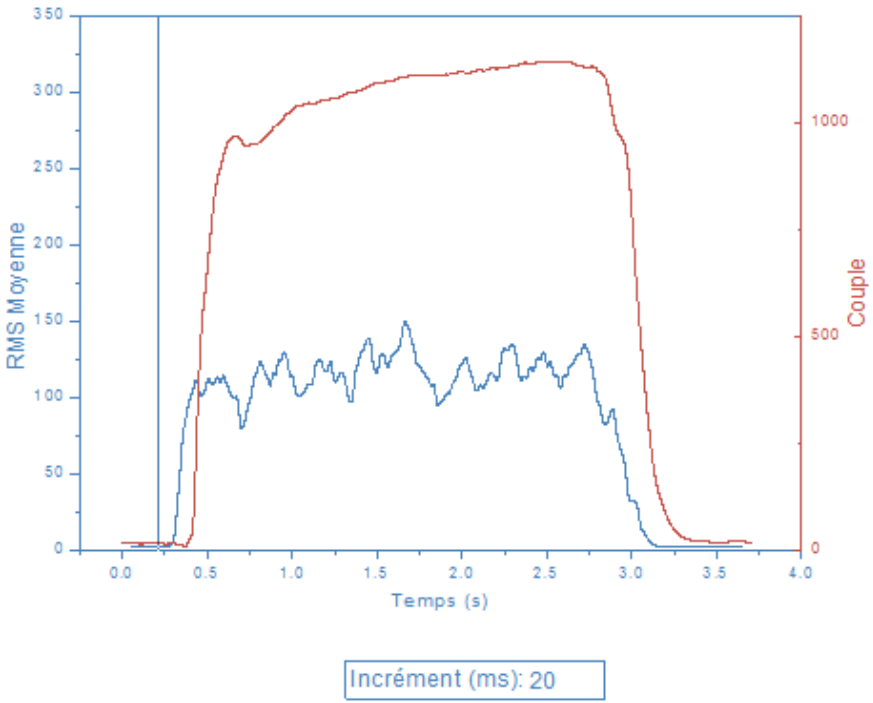
Before **After**



DESIGN

Multi-channel EMG





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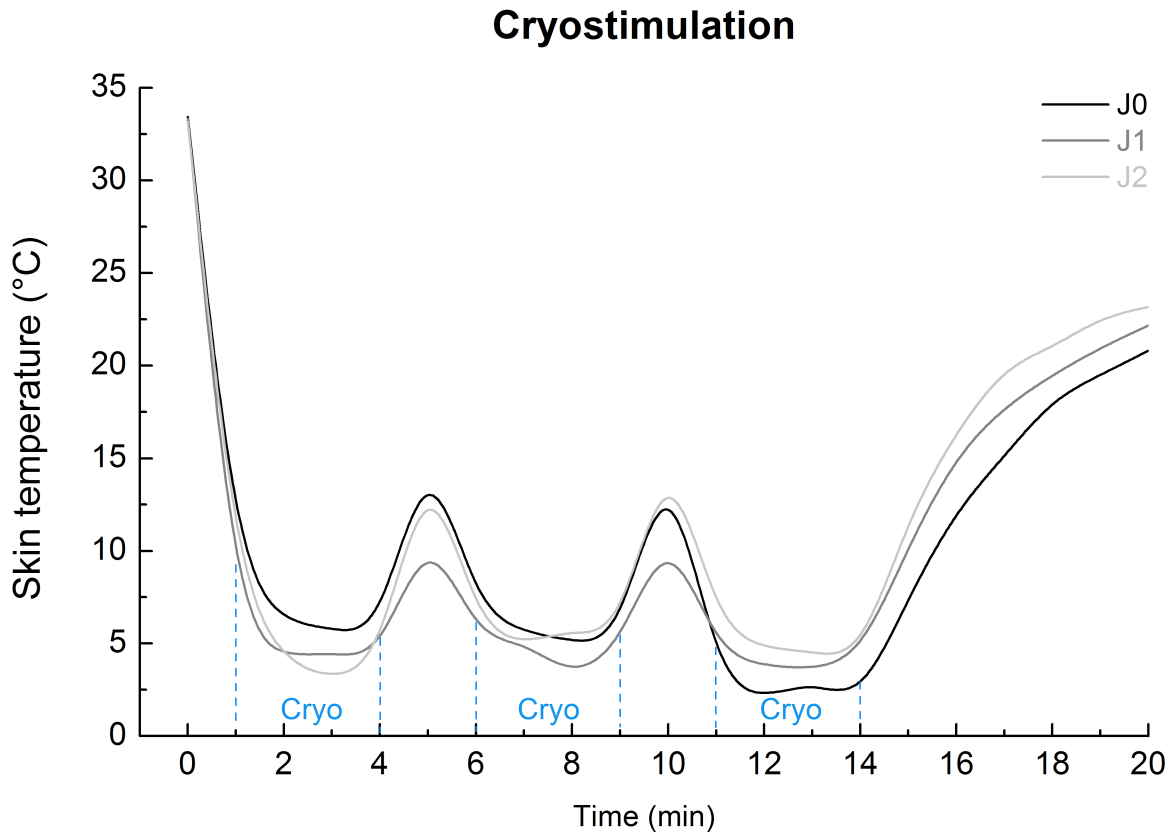
CRYOSTIMULATION



- Recommendations: ⬇ 10-15°C during 20 min

(Mc Auley, 2001)

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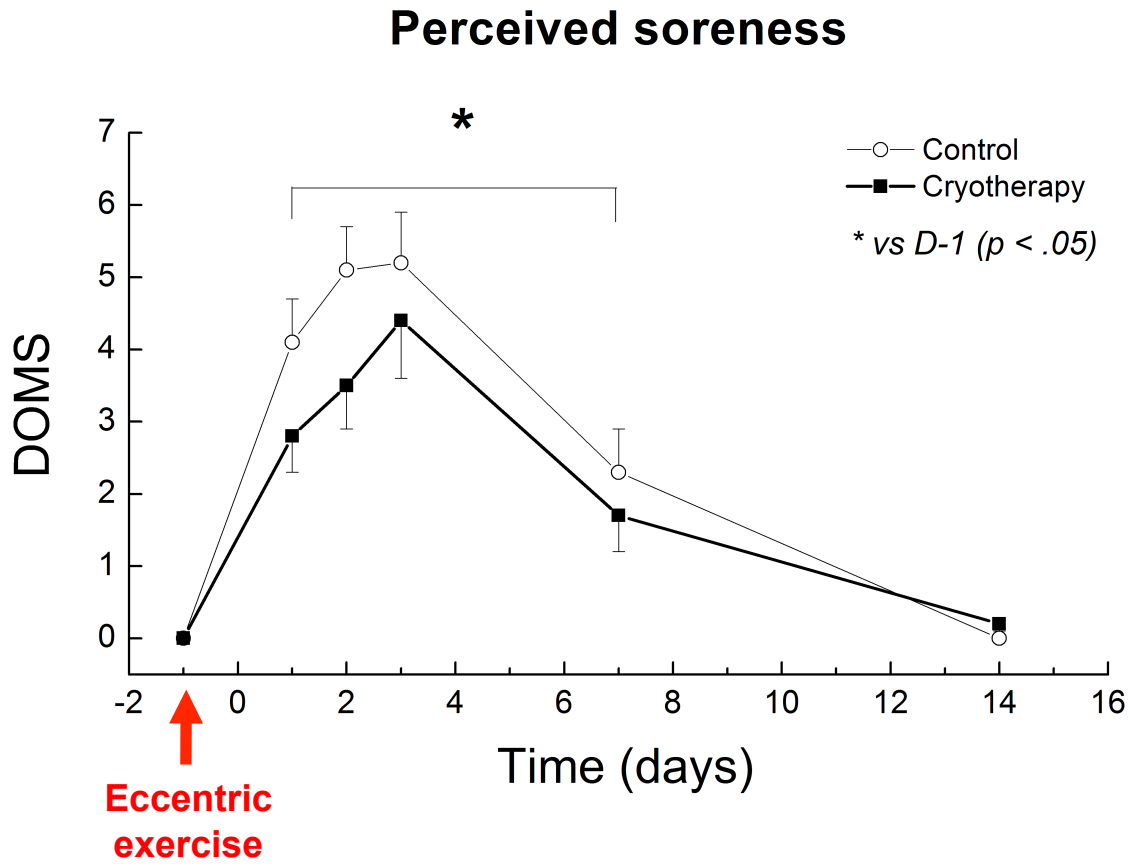
RESULTS



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CONCLUSION

- Above acceptable levels of damages

  ➡ No major effect of local cryotherapy

- For reasonable muscle damages

  ➡ Some positive effects emerge

  ➡ ⬇ DOMS, = maximal strength

  ➡ In accordance with cellular changes

- Relevance of prolonged (chronic) application (Fu et al. 1997)

  ➡ Possible « rebound » effect on oedema following the stop of cryotherapy

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THANK YOU

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CASE STUDIES

Recovery from…

… Water immersion…

… EMS from Veinoplus®

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AIMS

- Check whether the techniques are really effective
- For whom?
- Establish the optimal time of use

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4 STUDIES

Immersion

Veinoplus®

Synchronized swimming
(x1)

Soccer
(x2)

Handball
(x1)

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Overall Design

Exhausted exercise :

- ❑ Water ballet;
- ❑ Yo-Yo test;
- ❑ Eccentric repeated exercise

Recovery modalities

Exhausted exercise :

- ❑ Water ballet;
- ❑ Yo-Yo test;
- ❑ Eccentric repeated exercise

+ Blood samples
+ Psychological scales

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MAIN RESULTS

- Short-term recovery effects

	Performance	Physiological markers
Contrast Water Temperature (8°C/42°C)	+ +	+
Cold Water Immersion (8°C)	-	+
Hot Water Immersion	- - -	- -
Veinoplus® (Blood flow stimulation)	+ + +	+ +

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MAIN RESULTS

- Training recovery effects

	Performance	Physiological markers
Contrast Water Temperature (8°C/42°C)	+	+
Cold Water Immersion (8°C)	+ +	+ + +
Hot Water Immersion	-	-
Veinoplus® (Blood flow stimulation)	+ +	+

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PRACTICAL ADVICES

Immediately after a fatiguing exercise and between training sessions:

- ✓ CWT or V^+ (or active recovery)

Between two training days:

- ✓ CWI