Sports specific applications of compression:

*Inflammatory implications and recommendations for future research*
Overall effect: $p < 0.00001$, $Z = 5.46$, $ES = 0.38$ [0.25, 0.51]
Effect size (± 95% CI)

Time-point

- Power
- Endurance
- Strength

-0.4
0.1
0.6
1.1
1.6

0-2 h
2-8 h
24 h
>24 h

Performance Outcome
Rugby - Performance

= Physiological tests (NIRS, mid-thigh girth, soreness, creatine kinase activity)

= Performance tests (peak knee-extension force, 30 m sprint, CMJ)
The effect of CG on strength recovery in rugby players

\[ \gamma = \text{significant time x group effect} \ (p < 0.001) \]

Asterisks indicate a significant difference from baseline values \((p < 0.001)\)
The effect of CG on strength recovery in rugby players

ES = 0.93 [0.29, 1.57]

ES = 0.98 [0.34, 1.63]
The effect of CG on strength recovery in rugby players

\[ \gamma = \text{significant time x group effect} \ (p < 0.05) \]

Asterisks indicate a significant difference from baseline values \((p < 0.05)\):

- ES = 0.92 [0.28, 1.56]
- ES = 0.93 [0.29, 1.57]
- ES = 0.98 [0.34, 1.63]
The effect of CG on swelling and [CK] in rugby players

\[ \gamma = \text{significant time x group effect (} p < 0.001\); \ \mu = \text{significant difference from baseline (} p < 0.05\) \]

\[ * = \text{significant difference from baseline (} p < 0.001\) \]
The effect of CG on swelling and [CK] in rugby players

ES = 1.28 [0.62, 1.95]

ES = 1.07 [0.42, 1.72]

ES = 0.35 [-0.27, 0.97]
The effect of CG on swelling and [CK] in rugby players

ES = 1.28 [0.62, 1.95]

ES = 0.97 [0.33, 1.62]

ES = 1.07 [0.42, 1.72]

ES = 0.35 [-0.27, 0.97]
Elite athlete studies
a = Crossover trial

b = Parallel group trial

* = Significant difference in pressure
γ = Significant difference in COV ($p \leq 0.05$)
Meta-analysis showed no effect of pressure

- Limited by number of trials taking direct measurements and distribution of trials eliciting EIMD vs other exercise modalities
  - Beliard et al., (2015)
    - Running
- Hill et al., (2017)
Changes in T2 relaxation time of the VL with compression (Miyamoto et al., 2014)

- Unknown whether improved exercise recovery is related to observed reductions in limb circumference
- Pressure optima?
  - Watanuki et al., (1994)
  - Lee et al., (2018)

Swelling
Mechanistic insight will help to guide future research

- Benefits to performance observed alongside reductions in swelling
  - Goto & Morishima (2014)
  - Kraemer et al., (1996)
  - Kraemer et al., (2001)
  - Fragala (2010)
  - Arabi (2015)
  - Driller & Halson, (2013)
- Only study to report a benefit from CG on recovery from damaging exercise without a concomitant improvement in swelling
  - Mizuno et al., (2016)
● Anti-inflammatory mechanism would explain post-exercise benefits from CG following EIMD

- CG reduce tissue inflammation in a clinical setting (Beidler et al., 2009; Gohel et al., 2008)
  - Oedema playing a mechanistic role?
- Leukocyte adhesion $\uparrow x 100$ with vascular stasis (Lawrence, Smith, Eskin, & McIntire, 1990; Lawrence, McIntire, & Eskin, 1987).
- Associated with reduced circulating ROS following prolonged standing in healthy participants (Flore et al., 2007; Okamoto et al., 2013).
Endothelial Contraction
Potential mechanisms

- Anti-inflammatory mechanism would explain post-exercise benefits from CG following EIMD

- Infiltration of albumin, CD3+ (T-cells) and MPO (neutrophils)

- Pressure not measured
- Garments worn only throughout exercise
  - 40 min downhill running
  - -10 % slope
  - 73 % VO2max
- No detail on how long afterwards athletes were permitted to keep wearing the garments
- Muscle oscillation?
  - Anti-inflammatory effects?
Repeated Bout Effect (RBE)

- Inflammatory aspect to RBE (a - Dehyle et al., 2016)
- Neural component (b - Chen et al., 2018)
- Compression has been shown to reduce circulating markers of EIMD (Kraemer et al., 2001, 2010), local inflammatory activity (Beidler et al., 2009)

Studying the effects of CG on RBE could help guide the appropriate use of CG to optimise adaptation
Analysis of RBE
Compressing adaptation?

Mechanistic study...

- Compression (> 20 mmHg at the medial calf and > 15 mmHg at the mid-thigh)
- Muscle damage
- Control
- Muscle biopsies taken
- Flow cytometry to identify specific leukocytes from specific integrins
  - T-cells (CD3, CD4, CD8, CD45RA, CD27)
  - Monocytes/macrophages (CD14, CD16, CD45, CD163)
  - Neutrophils (CD16, CD15, CD11b, CD66b)
- Alterations in redox homeostasis
Conclusions

- Custom fitted CG enhance recovery from exercise-induced muscle damage
  - Strength performance
  - Swelling
    - Muscular trauma?
    - Haemodynamic effects?
- Custom fitted CG can be made to apply higher, more precise pressures
- Future research should explore:
  - The effect of training status
  - Optimal pressures
  - Mechanisms
  - Adaptation

...to guide best practise