Title

The acute physiological and perceptual responses to Blood-flow Restriction applied during un-resisted knee exercise: A Potential Treatment Adjunct for Physiotherapists

Authors

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Purpose: Blood-flow restriction [BfR] training involves the temporary, artificial reduction of blood flow through a limb. Evidence suggests that BfR combined with low intensity resistance exercise can minimise the loss of thigh muscle size and strength during periods of impaired weightbearing. However, evidence is scarce as to the specific utility of adding BfR to un-resisted or 'no-load' exercise during injury rehabilitation. Therefore, this case series examined the effects of applying BfR during a no-load lower-limb knee exercise completed by athletes recovering from significant lower limb injuries.

Methods: Three professional rugby players provided consent to incorporate BfR training into their injury rehabilitation programmes. (Case one; four weeks post tibia and fibula fracture. Case two; five weeks post Achilles tendon rupture. Case three; immediately following MRI diagnosis of an osseous stress injury of the knee). During the control exercise session, players performed three sets of a seated, un-resisted, single-leg knee-extension exercise. At subsequent sessions, a 21.5 cm wide blood-pressure cuff was used to superimpose BfR over the same exercise. BfR was applied intermittently or continuously across the upper thigh via 100mmHg or 120mmHg cuff pressure. Near infra-red spectroscopy [NIRS] monitored tissue oxygen saturation [SmO2] and total haemoglobin mass [tHb] of the vastus lateralis muscle before and during the exercise of each lower-limb. The relative change in SmO2 and tHb generated during each exercise session was then calculated. Session rate of perceived exertion [RPE] was monitored via a 10-point visual scale.
Descriptive statistics were then used to indicate trends among these variables.

Results: BfR training was delivered four to five times per week for periods of 4 to 12 weeks. NIRS data from thirty BfRT sessions (five sessions per leg, per player) were obtained. Mean resting values for vastus lateralis SmO2 and tHb were 54.3% and 12.72 g/dL respectively. During the control exercise session, SmO2 increased by a mean of 4.68 points, whilst tHb decreased slightly (-0.04 g/dL). In contrast, the addition of continuous BfR at 120mmHg generated a mean drop in SmO2 of 22.31 points, whilst tHb increased (+0.23 g/dL). No adverse events or pain occurred during any exercise session. The control session generated a mean session RPE of 0.94 out of 10. Session RPE during BfR training ranged between 3.6 and 4.9.

Conclusion(s): In a case series of injured athletes, data indicated that adding BfR to a 'no-load' knee extension exercise generated oxygen desaturation of the vastus lateralis muscle and increased perceptual exertion. Lower-limb BfR training was delivered in a safe, tolerable way as part of a multi-modal, intensive injury rehabilitation programme.

Implications: BfR training may provide Physiotherapists with a novel Method of generating exercise-induced physiological stress within muscle tissue during exercise, without the need to add any external resistance. Achieving sufficient physiological stress during the very early stages of injury rehabilitation via no-load BfR training may promote a muscular response that limits the longitudinal muscle disuse atrophy seen during periods of impaired weight-bearing. Further research is warranted to substantiate this and to explore the utility of no-load BfR training within non-athletic, clinical populations.

Keywords

Blood-flow Restriction; BfRT; Injury Rehabilitation

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Ethics Approval

Ethical approval was granted by the Faculty Ethics Committee of Manchester Metropolitan University (Application number 1269).