Muscle adaptations and protein expression following blood flow restriction and heavy-load resistance training methods

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Introduction: Blood flow restriction training (BFRT) improves skeletal muscle size and strength but most often to a lesser degree than traditional heavy load resistance training (HLRT) (Karabulut *et al.*, 2010; Kubo *et al.*, 2006). However, despite the ability of BFRT to induce muscle hypertrophy that is, importantly, without the use of heavy loads, the acute intramuscular anabolic and catabolic signaling pathways of BFRT remain largely under investigated. In particular, muscle adaptations following BFRT have not been directly attributed to acute protein expression of growth markers, nor have these been compared with expression following HLRT. Additionally, the change in protein expression has not been investigated throughout a BFRT programme. Therefore, we aimed to investigate intramuscular protein expression following BFRT and HLRT to determine if differences in adaptations to muscle size or strength may be attributable to different anabolic and catabolic signaling.

Methods: Untrained male subjects (aged 18-30 years) were allocated to a BFRT (n = 8), HLRT (n = 9), or non-training control group (CON; n = 9). BFRT and HLRT performed 8 weeks (3 sessions per week) of knee flexion and extension exercises (BFRT = 20% one-repetition maximum (1-RM); HLRT = 70% 1-RM). During all training sessions BFRT subjects had pressurized cuffs applied to the upper thighs and inflated to 60% of individual limb occlusion pressure (129 ± 11 mmHg; mean ± SD). Knee flexion and extension strength (*via* 1-RM), and total muscle cross-sectional area (CSA) at 50% of femur length (*via* peripheral quantitative computed tomography) were assessed pre- and post-training programme. Muscle biopsies were taken from the *vastus lateralis* before and after the first and last training sessions and analysed for expression of markers of protein synthesis (mTOR, p70S6K1, JNK, ERK 1/2) and degradation (4E-BP1, MuRF-1) using Western blots.

Results: Knee extension 1-RM strength increased similarly in HLRT (13.2 ± 1.7 kg; mean ± SEM), and BFRT (12.9 ± 1.0 kg) ($P < 0.05$), but not CON (2.0 ± 1.1 kg). Knee flexion 1-RM strength and muscle CSA also modestly increased yet did not differ between all groups. Expression of protein synthesis markers, and MuRF-1 were similar between HLRT and BFRT following both the first and last training sessions. In the first training session only, 4E-BP1 phosphorylation was reduced in HLRT post-exercise and was lower than CON, but did not significantly reduce following BFRT.

Conclusions: These results show that BFRT and HLRT induce similar improvements to muscle strength, yet only modest muscle hypertrophy during short training programmes. As such, we conclude that an initial acute increase in catabolic signaling seen for HLRT does little to separate the short-term training benefits of HLRT and BFRT.

Karabulut M, Abe T, Sato Y & Bemben M. (2010) *Eur J Appl Physiol* **108**: 147-55.

Kubo K, Komuro T, Ishiguro N, Tsunoda N, Sato Y, Ishii N, Kanehisa H & Fukunaga T. (2006) *J Appl Biomech* **22**: 112-9.