Isoinertial versus isotonic training for the prevention of sarcopenia

Pearson G, Maganaris C, Mollinello A, Tam E, Narici MV

Manchester Metropolitan University, Manchester UK

Introduction

Studies demonstrate that strength training can help partly reverse the physical frailty of elderly subjects which is known to be strongly associated with sarcopenia (1). Because sarcopenia is caused by a loss of muscle fibres, secondary to motoneuron loss, but also by progressive disuse (2), the aim of the present study was to investigate the effectiveness of strength training in preventing that part of sarcopenia associated with disuse. Because the increases in muscle strength are greater after eccentric (E) than concentric (C) strength training (3), in order to ascertain whether E contractions would be more effective than C contractions in increasing muscle size, the present study compared three different programs based on C+E and C contractions only. The eccentric/concentric (E/C) contractions were performed on an inertial loading machine (the Yoyo) while the concentric contractions (C) were performed on isotonic devices (Technogym©).

Methods

Fortyone subjects (20 females) were recruited from the local population and Informed Written Consent and GP's Medical Approval were obtained to take part in our 8-week-long training programs. They were randomly divided: Group 1 (n=12) trained on the isotonic machines (included leg extensor, rotary calf and leg press). Group 1 (n=12) trained on the isoinertial E/C device, the isotonic rotary calf device and carried out free squats. Group 3 (n=17) also trained on the isoinertial E/C device, carried out free squats and dynamic step exercises. As well as the main sets of strength training schedules, other types of exercises were incorporated in the training routine of all three groups so as to bring a more holistic benefit to the subjects (aerobics warm-up, balance and coordination exercises, upper body strength exercises, cool down including tai-chi-based movements). Training was performed either 3 times (Groups 1 & 2) or twice (Group 3) a week under supervision, plus one home-based session consisting mainly of therapeutic-band strength exercises and stretches.

For the assessment of sarcopenia and its changes with training, the muscle groups of interest included the gastrocnemius (*gastrocnemius medialis* in particular) and the quadriceps (especially the thickness of *Vastus Lateralis* (VL) *& Intermedius* (VI), as seen as 50% of thigh length in the coronal plane during quiet stance). Ultrasound Imagery was used to assess muscle pennation angle whilst Magnetic Resonance Imagery (MRI) was used to compute muscle volumes and physiological Cross-Sectional Area.

Results

At baseline, none of the muscle characteristics were significantly different between our groups. Results show a trend for total VL&VI thickness, to show a stepwise increase in the magnitude of the decrease in sarcopaenia such that Group 1<Group2<Group3. In other words, whilst the subjects who trained with "their baseline optimal power inertial load (100% BOPIL)" throughout the 8-weeks, increasing from 8-48 contractions showed an 155% muscle thickness increment (Group 1), those who also trained using inertial load but increased their load from 8 contractions at 100% BOPIL to 36 contractions at ~120% BOPIL showed a 5120% muscle thickness increment (Group 3). The isotonic–trained population (Group 2), who had incremented their training load from 8 contractions at 80% of 1RM to 48 contractions at 100% of 1RM, fell in the middle in terms of muscle thickness increments with a 217% increase in muscle size. However this picture masks a more interesting fact which is that where specificity of training is concerned, the VL size increment in Groups 1 and 3 (both inertial loading groups) are in fact respectively 53% and 69% greater than that seen in Group 2 (isotonically loaded participants).

Discussion

Our preliminary results also support the idea that the muscle packing density is better improved under progressive inertial loading conditions in that whereas VL pennation angle showed no significant changes in either Group 2 (37% increment) or Group 1 (46% decrement), Group 3 showed a dramatic pennation angle increment of 3015%. Interestingly, whilst in the case of total VL&VI thickness, the females of Group 1 showed significantly greater benefits than their male counterparts, in the case of VL thickness, again in Group 1, the males actually doubled their baseline values whereas the females only exhibited a 5% increment, suggesting a better training specificity of VL inertial training in males compared to females.

Conclusions

In conclusion, our Ultrasound imagery data are encouraging: inertial fly-wheel loading seems to be the better option when trying to increment muscle size in older populations, more so when a regime of progressive increment in load is observed. Moreover, a secondary finding from this study leads us to advise that future studies include one gender at a time since some of the results might be "hidden" due to gender specificity of the responses to training. We expect to demonstrate more details concerning the internal structure of the muscle once all our MRI data have been acquired and processed.

Bibliography

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