Triceps surae muscle power, volume and quality in older versus younger healthy men

Thom Jeanette M1, Morse Chris I1, Birch Karen M2, Narici Marco V1
1 Institute for Biophysical and Clinical Research into Human Movement, Manchester Metropolitan University, UK
2 University of Leeds Institute of Sport and Exercise Science, University of Leeds, UK

Introduction
Loss in muscle power with age occurs at a greater rate than the loss of muscle strength and has been shown to be more detrimental to the ability of older individuals to accomplish normal daily functional activities (Skelton et al., 2002). If the loss of muscle power were scaled in proportion to the loss of muscle volume, then no difference in ‘specific power’ (power normalised to muscle volume) should be observed. However, only few studies have investigated the effect of ageing on specific muscle power (Marsh et al., 1999; Martin et al., 2000). Thus the purpose of this study was to investigate whether specific muscle power of young and older men differ, and to discuss the origins of any possible difference.

Methods
Thirty healthy, recreationally active men volunteered to participate in this study. The participants were divided into two groups (i) older men (OM: n=18, age: 73.9 ± 3.8 years (range 69-82 years), height: 171.4 ± 4.9 cm, mass: 78.0 ± 8.2 kg, mean ± SD) and (ii) young men (YM: n=12, age: 26.5 ± 4.1 years (range 19-35 years), height: 178.1 ± 7.1 cm, mass: 76.9 ± 10.7 kg). Plantar flexor maximal voluntary isometric (MVC) strength was measured using a Cybex® dynamometer with the subjects lying prone and the ankle 0 degrees (neutral) (knee at 180°). Maximal concentric isokinetic torque of the plantarflexors was measured at 50, 100, 150, 200 and 250 degree.s^-1, from which peak power was observed (PP_{obs}) and estimated (PP_{est}) using Hill’s equation (Hill, 1938). Optimal torque (T_{opt}) and optimal velocity (V_{opt}) were also calculated (Josephson, 1993). Magnetic resonance imaging was used to assess triceps surae (TS) muscle volume (from soleus, medial and lateral gastrocnemius muscle cross sectional areas at 1 cm intervals) (Morse et al., 2004). Maximal power was normalised to body weight and to muscle volume (specific power).

Results
The isokinetic torque of the OM was significantly lower than that of the YM at all concentric velocities (40.5 – 56.2% of YM, P<0.001) and in isometric (62.6%) contractions. TS PP_{est} of the OM was only 43.3% of that of the YM (P<0.001). The calculated T_{opt} and V_{opt} from Hill’s equation showed that the OM had a 50.1% lower T_{opt} than the YM (28.5 Nm and 57.1 Nm, respectively), whereas the V_{opt} was 86.8% that of the OM (3.6 rad·s^{-1}) compared with the YM (4.1 rad·s^{-1}). The velocity at which maximal PP_{obs} occurred was not statistically different between the OM and YM (3.73 ± 0.21 and 4.15 ± 0.16 rad·s^{-1}, respectively), TS muscle volume of the OM was 19% smaller than that of the YM (7.41 ± 0.19 x 10^{-4} m³ and 9.16 ± 0.47 x 10^{-4} m³, respectively, P<0.001). The maximum specific power (PP_{est} muscle volume) of the OM was 55.2% lower than that of the YM (P<0.001). OM had a 28% lower P_{t} than YM (12.9 ± 0.6 Nm compared to 16.6 ± 1.5 Nm respectively, P<0.05). The OM had a 23% longer TPT (114.7 ± 7.6 ms vs. 87.8 ± 3.7 ms, P<0.01), but showed no difference in ½RT (107.2 ± 6.2 ms vs. 100.5 ± 4.7 ms, ns) compared with the YM. When TPT and ½RT were normalised to P_{t}, both were found to be slower in the OM group than the YM (TPT/P_{t}: 9.4 ± 0.8 ms·Nm^{-1} vs. 5.7 ± 0.5 ms·Nm^{-1}, P<0.01, and ½RT/P_{t}: 8.6 ± 0.6 ms·Nm^{-1} vs. 6.6 ± 0.7 ms·Nm^{-1}, P<0.05, in OM and YM respectively).

Conclusion
In conclusion, the maximal muscle power in older men was found to be ~ 50% that of young men. About half of this difference in power was accounted by a reduction in muscle volume suggesting that other factors, such as MHC composition, myosin molecule intrinsic speed, specific tension and neural drive may account for the remaining half of the power loss. The observation that a reduction in torque is the major determinant of the loss in power output underlines the importance of resistance training programmes for recovering power output and functional performance in old age.

References

Acknowledgements