Histochemical and tensiomyographical analysis of sedentary men and sprinters biceps femoris

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Introduction

The histochemical, immunohistochemical and biochemical techniques for obtaining biochemical characterisation of different fibre types and function in skeletal muscles during exercise have been widely used. The slow twitch fibres predominate in the muscle of endurance athletes (Gollnick et al. 1972). With endurance training, type 2 fibres become more aerobic. The study of Jansson et al. (1990) indicates that it is possible to achieve a fibre type transformation in the vastus lateralis muscle with high intensity training. There are very few reports on the histochemical structure and on the effect of short-term high-intensity training on the contractile properties of the biceps femoris muscle (BF). Since it has been demonstrated there exists a correlation between the whole-muscle twitch contraction time measured by tensiomyography (TMG) and the histochemically determined percentage of slow twitch muscle fibres (Dahmane et al. 2001, we proposed the TMG as a non-invasive alternative to an invasive histochemical analysis. In this work our intent is to: (a) Investigate the histochemical structure of the biceps femoris muscle in two groups of sedentary and sprint trained young men. Sprinter’s training was assumed for perfect model for study of cronical short-term high-intensity training influence on muscle contractile properties.

Methods

Biceps femoris muscle samples were taken at autopsy from one group of 15 men aged between 17 - 35 years, who had died suddenly. In mature human skeletal muscles type 1, 2a, 2b and 2c fibres can be determined according to the activity of myofibrillar adenosine triphosphatase (mATPase) and for immunohistochemical fibre typing myosin heavy chain (MHC) isoforms are used as molecular markers (Danieli-Betto et al. 1986). A second group of 15 healthy sedentary male subjects, aged 17-35, and a third group of 15 mail sprinters, aged 19-31 years, was recruited for this study. The sprinters completed a 20m maximal velocity test with flying start (35-40m). Subjects from the second and third group were placed in standard measurement position (Dahmane et al. 2001) for measuring BF. Each muscle was twitch stimulated with two bipolarly placed electrodes on the skin above the muscle head. Supramaximal muscle response was then recorded using TMG and stored for further analysis. We monitored Tc (contraction time).

Results

Histochemical results of the sedentary group revealed a substantial percentage of intermediate type 2c fibres (5.7% ± 0.7) in the biceps femoris compared to other limb muscles. Approximately the same percentage of 2c fibre type is obtained using immunohistochemical method (5.9% ± 0.6). Tc of sedentary young men biceps femoris was 30.25 ± 3.5ms. For the sprinters group the contraction time was significantly shorter (19.5 ± 2.3 ms). For the sprinters group the contraction time was significantly shorter (19.5 ± 2.3 ms).

Discussion / Conclusion

Differences in postnatal maturation rates of various muscles most likely relate to different usage and loading patterns (Pette and Staron 1997). It has been shown that the normally occurring postnatal transition of type 2a into type 1 fibres causes a higher proportion of type 2c fibres during rapid growth. We assume that BF contractile properties can change due to altered functional demands, because BF has a relatively high proportion of 2c fibres. Our results also showed a correlation (r = 0.72) between BF contraction time and running speed on 20 m running. The prolonged and increased amplitude of the hamstring contraction during maximal and supramaximal running speed (Kyrolainen et al. 1999) support the hypothesis that the BF can be a limiting factor for maximal speed development.

In conclusion, from our data and analyses it appears the presence of a relatively high proportion of 2c fibres in the biceps femoris of the sedentary young men might increase the muscles potential to tune its adaptive response. In addition, a successful sprinter with a high running speed is characterised by a short BF contraction time and a greater percentage of type 2 fibres, achieved at the expense of type 1 fibres. The 2c fibres can be a transitory link between types 2 and 1 during fibre transformation.

References