DISTRIBUTION OF DIFFERENT FIBRE TYPES IN NUMAN SKELETAL MUSCLE AND THEIR RELATION WITH NEUROMUSCULAR PERFORMANCE

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Introduction

The physiological, morphological, and biochemical responses of skeletal muscle have been extensively studied. Several recent studies have correlated different functional capacities of the intact human skeletal muscle, such as endurance, contraction velocity and strength, to the distribution of different fibre types in the muscle. A number of these studies have indicated that the tension per cross-sectional area unit is greater for the Type II (fast-twitch) fibers than for the Type I (slow-twitch) fibres. The purpose of this study was to compare twitch, tetanic, maximal voluntary contraction (MVC) with histochemically determined fibre type parameters in the triceps surae muscle group.

Methods

Sex subjects males volunteered for the study. Five the subjects were between the age of 20 and 30 years and one male was 38 years of age. The groups represented a variety of physical activity profiles, although none were considered extremely sedentary. The initial physical activity patterns for all subjects remained unchanged over the course of the investigation. The contractile properties of the triceps surae muscle group were measured using similar methods and procedures as described by Koryak (1995). The right leg was firmly clamped in a specially designed leg dunamometer in a standard position at a knee joint angle between the tibia and the sole of the foot 90°. The isometric twitch and tetanic contractions of the triceps surae muscle were induced by electrical stimulation of the tibial nerve supramaximal rectangular electrical pulses of 1 ms duration with a frequency of 150 Hz for the tetanic contractions [Koryak, 1995]. Stimulation of the tibial nerve was by a monopolar electrode. Twitch contractile measurements was included peak-twitch tension (P_t), time-to-peak tension (TPT), and half-relaxation time (1/2RT). Tetanic tension (P_o) were recorded during stimulation at 150 Hz at 30-40 V [Koryak, 1995]. The third test consisted of three MVC. The highest force of the three trials was recorded as the MVC. Within two day of the measurement of the contractile properties, needle muscle biopsies, using the technique described by Bergstrom (1962). The sample was taken from the belly of the right lateral gastrocnemius (LG) muscle. The samples were immediately frozen in cooled isopentane (using liquid N_2) and stored at -80° C. Serial section, 10 μm in thickness, were cut from each sample using a cryostat maintained at -20° C. The sections were stained for myo-ATPase after alkaline (pH 10.4) or acid (pH 4.3) pre-incubation (Brooke, Kaiser, 1970). To classify the fibers as either Type I (ST) or Type II (FT), between 75 and 300 fibres were counted in each of the two myo-ATPase stained sections.

Results

Baseline data showed that the subjects had a significantly lower mean MVC (485.6 ± 38.3 N) compared to P_o (624.9 ± 41.2 N). Twitch tension (P_t), TPT, and 1/2RT agreed closely with values published previously (Vandervoot, McComas, 1986; Koryak, 1995). The histochemical parametrs determined from the biopsy samples of the LG indication that the average distribution of ST fibres in the biopsy samples was 49.4 ± 14.4 % with a wide range of values from 30 to 91 %. Significant positive correlations were obtained for % ST and TPT ($r = 0.61$; $p < 0.05$), % ST and 1/2RT ($r = 0.81$; $p < 0.01$), and negative correlations were obtained for % ST and P_o ($r = -0.86$; $p < 0.01$). P_t and MVC forces did not show significant relationship with % ST fibres.

Conclusions

The absence of a relationship between contractions properties and fibre type distribution in some experiments may be attributed to use the voluntary contraction the features of which are an integral reflexion of both contractile properties of the muscles and the peculiarities of their CNS.

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GENERAL AND SPECIAL WORKING CAPACITY OF TRACK AND FIELD ATHLETES SPRINTERS AND STAYERS

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Physical working capacity is referred to the number of integral showings which are widely used for trackmen's potentiality estimation. There is a multitude of methods to define physical efficiency: based on maximum oxygen consumption measurement (MOC), PWC_{170} test submission, lactic acid accumulation, anaerobic boundary, etc. The following questions arise fair-mindedly: Is only one and the same state evaluated by these methods? Are all the sides of physical efficiency diagnosed? Is it better to evaluate general or specific capability? How to define which defining method is the most suitable for physical condition evaluation?

As it is known, the work-out session in track and field is aimed at the development of either sprinter or stayer functional capabilities. In the previous work (Lazareva E.A., 2003) it was found that the defining of general physical efficiency with such a popular me-

thod as MOC measuring in the test of gradually increasing load shows the highest efficiency coefficients at stayers compared to sprinters. But can it say for a worse physical condition of sprinters (having the same category as stayers do)? The answer is negative because physical efficiency measurement of the same sportsmen in specific zones of relative potency shows that sprinters excel with maximal potency coefficients in the zone of anaerobic energy production; and stayers exercise maximal muscular power in the zone of aerobic and combined energy production, testifying that that the caliber of both sprinters and stayers is defined by the predominant power supply source development degree and cannot be esteemed by general physical efficiency measurements. Really, if general physical efficiency (esteemed on the MOC showings) is defined by the final efficiency value, physical efficiency found out in the concrete zone of relative potency checks the development of the concrete bioenergy source and, therefore, bears more detailed information about the profile of energetic metabolism and allows detecting the predominant type of power supply. This confirms the idea that for effective trackmen's work-out session planning and physical efficiency diagnostics one should judge from the analysis of the results of a large number of tests. (Volkov N.I., 1989; Volkov N.I., Volkov A.N., 2004): gradually increasing load test for an integrated estimation of the maximum of aerobic and anaerobic capacities; critical power holding test for aerobic holding capacity estimation; single ultimate work test for glycolytic anaerobic power estimation; repeated ultimate work test for glycolytic anaerobic holding capacity estimation; ultimate anaerobic power test for anaerobic alactate capacity estimation; ultimate power reload test for alactate anaerobic holding capacity estimation. As a result of carrying out all these tests one can obtain an adequate valuation of physical fitness of a trackman – the physical fitness presupposing both general physical efficiency and all kinds of special working capacity data.

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HISTORY AND PROSPECTS OF SHAPE MEMORY ALLOYS APPLICATION IN SCIENCE, ENGINEERING AND MEDICINE

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In latter days multifunctional predetermined-properties materials – the ones, which can change their properties under the effect of external factors and operation conditions (temperature, mechanical loading, etc.), are finding more and more wider application in science, engineering and medicine. Certainly, the alloys with unique and most recently unknown physical and mechanical properties – thermomechanical shape memory effect (TME) and superelasticity (SE), refer to these materials. These alloys are able to reset unusually large inelastic deformations, show rubber-like behavior and damping properties, produce considerable stresses, etc., according to the predetermined program. It is generally recognized that the most vivid and the best representative of SE TME alloys is the intermetallic compound on the base of titanium nickelide NiTi – nitinol.

The application of shape memory super-elastic materials has allowed improving traditional properties and obtaining brand new functional ones of constructions having expanded their practical application areas radically. Non-detachable mechanical joints, drives, heat engines, fire alarms, various medical devices and instruments, vascular implants and filters, valves, occluders, bone implants, papillotomes, gallstone and urolith extractors, pulp extractors, hernioplasty meshes, etc., - these are a small part of these "intelligent" materials typical application examples.

During the last two-three decades in Russia and other technologically developed countries the shape memory alloys' application grows. On the results of a great number of investigations the international conferences ICOMAT, ESOMAT, EUROMAT, SMST, SMM, SMART, KUMICOM and others are held. A lot enough monographs and publications of fundamental and applied character testifying to considerable achievements in the sphere of titanium nickelide use appeared in the press. By now a great amount of patents on TME alloys, devices and products have been given. The most worked ideas and elaborations have reached the level of gross production, a definite part of products being made commercially. In spite of intent interest to these materials the information about the forecast application spheres of the last very often is incomplete or is contained in not easily accessible sources. The lack of special reference and bibliographical information on the given theme restricts the possibilities of scientific workers and engineers while solving concrete applied problems. The present paper informs about this gap compensation in terms of the patent base – one of the electronic library (EL) *e*SM@ divisions "Shape Memory Alloys Application In Science, Engineering And Medicine", creation. The base comprehends all the certificates of authorship and both native and foreign patents on the TME alloys from the date of their opening in 1960 up today. The resource has been registered in the Russian record of creation and utilization projects of the EL under the notion of "Information resources collection creation" and in electronic resources exchange scientific net.