Exam Optimizing Neuromuscular Performance Oct 26 th 2007; 15.15-18.00 hr in 1A05 and 2A05

€0.10

The following 6 questions have to be answered in English (10 points for each question: 60/6=10)

1. What would be the problems when voluntary isokinetic shortening contractions with shortening starting after complete development of isometric torque were to be used to construct a torque–velocity relationship of the knee extensors? Explain your answer.
Answer:
-shortening of the series elastic component plus explanation (5 points)
-shortening induced force deficit (5)
(problems related to activation)

2. A shot-putter (kogelstoter) and his coach come to your laboratory and they want to know whether the athlete is capable of maximally recruiting all his muscle fibres during maximal contractions of his knee extensors. Which measurements would you do and why? Explain.
Answer
- *isometric contractions with superimposed stimulations (4)*
- *fast explosive isometric contractions voluntary and electrically induced (6 points), because explosive contraction are important for a shotputter*

(dynamic shortening contractions with superimposed stimulation, muscle biopsies and measuring PCr/Cr)

3. During a sustained isometric knee extension at 50 % MTC (90° knee angle) subject J.d.R. previously failed to produce the required torque after about 60 s (range 55-65s). Describe the changes in firing rate of three different motor units (recruitment thresholds of respectively: 10%, 20 % and 49 % MTC) during a 30 s isometric contraction at 50 % MTC (90° knee angle). At the beginning of the contraction torque is build up gradually (10% MTC/sec), this is followed by the 30 sec plateau at 50 % MTC and at the end torque decline also is gradually (10% MTC/sec).
Describe **and explain** the (changes in) firing rates that will occur for the three units during the entire contraction (Thus including ramp up and down phases).
Answer:
-orderly recruitment and derecruitment with the first recruited unit firing at the highest rate (4)
-the49 % unit will fire irregular and will show an increase in firing rate during the 30 sec (2)
- the other units will show a decrease in firing rate (2)
-mechanism naming only one of the following would give you 2 points! (decrease muscle spi9ndle support, motor unit adaptation, increase Renshaw inhibition, potentation, increased inhibition via group III and IV afferents)

4. Describe the two types of potentiation dealt with during the course. What are their characteristics and underlying mechanisms?

Answer

(Both will only work in sub-maximally activated muscle)

-post tetanic potentiation: increase in twitch following a tetanus(3)

-myosin light chain phosphorylation (2)

-High frequency initial pulses: increased force output during submaximal activation following a few high frequency pulses (3)

-increased chance of cross-bridge binding due displacement of tropomyosin (2): not increased calcium, LC phosphorylation or pre-stretching of series elastic elements)

5. We measure the voluntary power velocity relation of a subjects' knee extensors under two different conditions: with and without pre-cooling of the legs (i.e. muscle temperatures of 25 and 35°C, respectively). (We use voluntary isovelocity contractions with a preload, thus with the motor starting to move at a certain estimated expected torque level during each contraction)

a. Draw the concentric torque-velocity relationships for both conditions and explain the expected differences (label the axis).

b. Speculate in which of the two conditions it would be more difficult to maximally activate the muscle fibres during the voluntary isovelocity shortening contractions? Explain your answer.

Answer a. small decrease in Fmax, large decrease in Vmax and increased curvature(decrease power) due to decreased c.b. cycling rate (myosin ATPase)(6)

b. More answers possible, 2 is enough

e.g. it becomes easier in the cold due to the leftward shift of the force frequency relationship (2)

it becomes more difficult in cold because of a decreased central activation(2) or easier in the cold because it is easier to maximally activated your muscles during slower contractions (2) etc.

6. Two subjects (1 and 2) perform an isometric knee extension (90° knee angle) at 30 % MTC with an cuff inflated around their thigh (450 mmHg). Subjects 1 and 2 have a subcutaneous fat layer covering their vastus lateralis muscle of respectively 6 and 16 mm.

a. Draw in one figure the signals sampled with a NIRS optode-set from the vastus lateralis muscles of both subjects. Explain your figure and the course of the signals (and label the axis and signals)

b. How would you determine with use of the NIRsignals whether there is a difference in vastus lateralis muscleVO2 between both subjects during this contraction?

a. increasesing signals of HHb with in mirror image decreasing HBO2 signals, which reach maximal dexoygenation (level off) at the same time in both subjects, only maximal deoxygenation is less in subject 2 leading to a lesser absolute slope in subject 2 (6)

b .normalizing the slope of the curves (mVO2) to maximal deoygenation (results probably in more or less the same mVO2 (4)