Review of: "Modelling Skeletal Muscle Motor Unit Recruitment Contributions to Contractile Function: Part 3 - Substrate Oxidation of Phosphagen, Lipid, and Carbohydrate Metabolism"

Willem J. van der Laarse[1]

1 Independent researcher

Potential competing interests: No potential competing interests to declare.

This study aims to calculate the contribution of metabolic processes to ATP turnover in human skeletal muscle as a function of contraction frequency and motor unit recruitment. It is important to understand metabolic changes during muscle contraction because they probably play roles in gene expression and training effects.

The contributions of the ATP resynthesizing reactions in different fibre types were estimated rather than measured: CrP, adenylate kinase, glycolytic metabolism resulting in lactate production and pyruvate oxidation, and fatty acid oxidation. Because the fluxes of these reactions in different human motor unit fibre types cannot be measured, the final results of the study depend on a large number of assumptions (equations 1-21).

Metabolic inhibition of ATPases, calcium activation, glycolysis, and mitochondria by phosphate, protons, magnesium, and IMP is not included in the model. Rate coding of motor unit force is not mentioned; rather, all-or-none twitch responses are used in the calculations. These factors add to the complexity of the system and impair experimental verification of the model results in the future.

The stimulus parameters used – continuous low-frequency stimulation – are unphysiological. In vivo stimulation consists of intermittent tetanic stimulation, e.g., during walking or cycling. Intermittent stimulation allows for redistribution of metabolites between contractions, which is especially important to prevent ADP inhibition when the PCr is fully reduced, facilitates lactate efflux, and promotes muscle blood flow.

[One possibility to test the metabolic model is to apply it to the measured metabolic fluxes in different isolated fibre types of Xenopus muscle fibres (Nagesser et al., 1993). For this preparation, ATP turnover for activation and cross-bridge cycling is also available (Elzinga et al., 1987).]

Minor points:

Human skeletal muscles do not contain IIB myosin but IIX (for review, Bottinelli R and Reggiani C, 2000).

Table 1. Please mention for clarity that these data apply to skinned muscle fibres at 12°C. Add a/P_0 to the Force-velocity relationship in column 1.

Methods

Add a reference and definition of “cellular biochemical efficiency’’

Change kJ M^{-1} to kJ mol^{-1}.

References

Bottinelli R and Reggiani C (2000) Progr Biophys Mol Biol 73, 195-262.

Elzinga G, Lannergren J, Stienen GJM (1987) J. Physiol 393, 399-412.

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