TORQUE-VELOCITY RELATION OF ARM CRANKING EXERCISE DETERMINED WITH STEPWISE LOADING METHOD

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We have shown that a recumbent-type cycle ergometer with using stepwise loading method is useful for a rapid evaluation of lower-limb muscle function (Yamauchi et al. 2005). However, it is unknown the application of such method in upper-limb muscle function. Therefore, we investigated the torque-velocity relation of arm cranking exercise on a cycle ergometer with using a stepwise loading method. Fourteen healthy subjects performed an arm cranking exercise at their maximal effort on a recumbent-type cycle ergometer with an electromagnetic load control. To determine the torque-velocity relation, the stepwise loading method was used. In this method, initially the external load was not applied, but when axial rotation velocity reached a maximum, it was successively increased in a stepwise manner within a bout until subjects were unable to move crank handles. The result showed that correlation coefficients between torque and velocity were varied in individuals (r=-0.55 to-0.99). In many subjects, the torque-velocity relation of arm cranking exercise determined with stepwise loading method was well described with linear functions, as previously shown for lower limb multi-joint movements (Yamauchi et al. 2005, in press). However, in some subjects, especially non-active women, there was no significant correlation between torque and velocity. This large variance may be related with movement skill since an arm cranking exercise is not common movement in daily activity as compared with leg cycling. The coordination of agonist-antagonist muscle activation is an important factor for skill of multi-joint movements because contractions of many muscles are involved at the same time. Our preliminary electromyographic measurements during the knee-hip extension movements showed that the linear appearance of force-velocity relation was affected by the coordination of muscle activity, which required managing the movement working properly (Yamauchi et al. 2004). Therefore, the present study further suggests that an improvement of muscular coordination may give rise to an improvement of performance in arm cranking exercise and make a linear appearance of torque-velocity relation. Although the present method has some limitations, it may be useful for a rapid evaluation of muscle dynamic properties in upper limb.

Keywords: Muscle Physiology, Biomechanics, Arm Crank