A comparative study of isokinetic training using two brands of dynamometers

Croisier JL, Herve MN, Forthomme B
Department of Physical Medicine and Rehabilitation, University of Liege, Belgium

Introduction

Compared with the use of isokinetics in testing, where there are relatively well-established rules and procedures, its clinical role in the conditioning of muscle performance is far less researched. The primary benefit of isokinetic resistance in training is that maximal overload of a muscle group can be achieved throughout a joint's available range of motion. By converse, isokinetic exercise may also be used to provide a sub-maximal form of resistance which offers great safety by the permanent adaptation of the load to the patient capacity. For instance, eccentric sub-maximal isokinetic exercises have been shown efficient in treating tendinitis (1).

The lack of compatibility between different brands of dynamometer was demonstrated in measurements (2). To our knowledge, no similar research has been conducted about the effects of a strengthening program using two different machines. The equipment particularities, that possibly generates differences in the counterforce exerted, justifies such investigation. The goal of our study was to compare the progress in muscle performance resulting from a standardized strengthening program applied with two different dynamometers.

Methods

24 male subjects with no experience in systematic strength training and free from previous knee injury were recruited. Mean age, body height and body mass were 22.2±2.3 years, 183.1±6.2 cm and 76±10.1 kg, with no differences between subsets. The subjects were randomly assigned to one of the two training groups or served as controls (CG, n=8). Isokinetic strength training of the quadriceps (Q) and knee flexors (Fl) was performed in two training groups using either a Genu 3 (TGenu, n=8) or a Biodex 3 (TBiod, n=8) dynamometer. The unilateral training protocol (on the dominant leg) consisted for both training groups in the same program: contractions at maximal intensity within a standardized range of motion, at the same velocities (60 and 240°/s) and identical number of repetitions. A total of 8 training sessions were performed over 3 weeks. The isokinetic maximal performance (peak torque, PT) was measured in the concentric mode (at 60°/s and 240°/s) on both devices (Genu 3 and Biodex 3) for all the 24 subjects. Measurements were performed 3 days before and after the training (for TGenu and TBiod) or rest (for CG) period. The testing machine order was randomly assigned in pre-test but the same order was respected in post-test. Measurements were preceded by a 10-15 min warm-up and preconditioning to the testing device.

Results

Modifications resulting from the 3 weeks of training or rest was calculated on PT (differences before/after, expressed in %) for each testing machine, velocity and muscle group. No significant difference was observed in the CG whatever the conditions of exercise. Other observations were as follows:

- Q at 60°/s: significant improvements, reaching 8-9% on average, but solely for the measurements performed on the device used in training.

- Q at 240°/s: significant improvements systematically observed in the TGenu (respectively 21±17% and 12±8% for tests on Genu 3 and Biodex 3) and TBiod (respectively 14±15% and 9±5% for tests on Genu 3 and Biodex 3).
- Fl at 60°/s: no significant modification in TBiod versus significant improvements in TGenu (respectively 24±21% and 15±13% for tests on Genu 3 and Biodex 3).
- Fl at 240°/s: no significant modification in TBiod versus significant improvements in TGenu (respectively 25±24% and 16±11 % for tests on Genu 3 and Biodex 3).

Discussion

Although being unavoidable in the treatment of some pathological disorders (3), the eccentric mode of contraction was not investigated in that study, because one device employed was not an active dynamometer able to generate the motion. Hence, our study focused on the short term effects of concentric exercises on the knee muscle strength. Following the principle of specificity in training, we expected to observe preferential improvements when a muscle was tested on the device used in training. In fact, such a profile concerned mainly the Q at low velocity. Interestingly, the Fl showed no significant progress after training on the Biodex 3 device, although training on the Genu 3 resulted in significant improvements on that muscle group, whatever the dynamometer used in testing. The Genu 3 dynamometer must be categorized as a passive system using a hydraulic braking principle to dissipate the force developed by the muscle. Due to the reaction time of such a system in regulating the predetermined exercise velocity, we highlight the sudden deceleration of the overspeeding limb and lever arm (after the initial acceleration generated by muscle contraction) which produces a transient peak in the curve. This phenomenon induces overload on the muscle structure during exercise, which could contribute to the findings reported in our study.

Conclusions

Knee muscle strengthening of healthy subjects seemed particularly efficient in the concentric mode when using a Genu 3 device. Obviously, the physiological mechanisms involved in that process must be investigated. The findings have also to be confirmed in pathological context.

Bibliography

1. Croisier et al, Isokin Exerc Sci, 9, 133-141, 2001
2. Greenberger et al, Isokin exerc Sci, 4, 70-75, 1994
3. Croisier et al, Am J Sports Med, 30, 199-203, 2002