

CON-TREX

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TESTING IN DIFFERENT ISOKINETIC MEASUREMENT MODES ON THE CON-TREX TRUNK MODULE

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INTRODUCTION

The muscles of the trunk play a decisive role for positioning the extremities and for postural stability, because all forces of motion and gravity transfer through it. Several authors describe the correlation between poor core stability respectively trunk muscle weakness and the risk for lower extremity injuries and low back pain (Gambetta 2002, Leetun et al. 2004, Iwai et al. 2004, Willson et al. 2005). Therefore trunk testing is of great interest in clinical research and functional training. Isometric testing does provide a measure of muscle strength, but it does not reflect how or if that strength works in a stabilizing manner (Sherry et al. 2005). The use of isokinetic devices is increasing due to the broad range of applications in rehabilitation, training and evaluation of muscle function (Bardis et al. 2004). The diversity of isokinetic instruments, protocols and normalisation factors makes it difficult to compare results of different studies (Dvir 2004). Con-Trex (Duebendorf, Switzerland) has developed different isokinetic measurement and training modes in response to the diverse requirements of strength testing and training in rehabilitation and high performance sport. It is not fully clear which mode is the most appropriate for testing high performance athletes and if all modes provide comparable results.

The purpose of the present study was to investigate differences in torque, mean power and maximal speed in three measurement modes: Isokinetic Classic Mode (ICM), Isokinetic Ballistic Mode (IBM) and Continuous Passive Motion (CPM) with a Con-Trex trunk module.

METHODS

Twenty freeride and freestyle snowboard and ski athletes (4♀, 16♂, mean + SD, age 27 + 4 yr, height 175 + 8 cm, body mass 68 + 8 kg) volunteered for the study. All subjects were injury free. The test device was a Con-Trex trunk module TP 1000 (Figure 1). The warm up program was: 10 min bike ergometer (100 W), stretching exercises for the trunk, 10 reps of side bridge, sit ups and hyperextensions followed by one familiarisation trial of each measurement mode. All subjects performed four maximal repetitions of concentric flexion (flex) and concentric extension (ext) in each mode of ICM, IBM and CPM in random order. In mode CPM the device moved the subject with a constant speed through the full range of motion (ROM). In ICM and IBM the subjects had to accelerate the device, but these 2 modes differed in their acceleration characteristics. In ICM the speed below the speed limit was proportional to the applied torque.

In IBM the Con-Trex ballistic software reduced the influence of inertia below the speed limit so that higher accelerations were possible. Speed was set at 120°/s and the ROM from the upright standing position (0°) to forward flexion in the hip was 60°. The legs, pelvis and chest were stabilized by pads and straps. All recorded torques were corrected for the effect of gravity. The best single measurement for maximal torque, flexor/extensor ratio of maximal torque, mean power and maximal speed for each mode was recorded. The statistical analysis was performed with a one-way analysis of variance (ANOVA) with post hoc Scheffé test and Pearson's correlation coefficients ($p < 0.05$) in SPSS 15.0.

Figure 1. Con-Trex trunk module



RESULTS

Table 1 shows the results of maximal torque, flexor/extensor ratio and mean power reached in the three measurement modes. There were no significant differences between the three modes and all parameters correlated significantly. The ICM mode produced the highest torque for flexion (CPM -2 % n.s., IBM -7 % n.s.) and extension (CPM -5 % n.s., IBM -5 % n.s.). The highest mean power values for flexion were in CPM (ICM -2 % n.s., IBM -4 % n.s.) and for extension in ICM (CPM -5 % n.s., IBM -5 % n.s.). The maximal speed in ICM was significantly lower than in the other two modes. With average maximal speed of 101 °/s in flexion and 116 °/s in extension not all athletes reached preset speed of 120 °/s in ICM. In CPM and IBM all subjects reached 120 °/s in flexion and extension.

Table 1. means and standard deviations' (SD) of maximal torque and ratio and mean power (P) for each mode

| parameter | max. torque [Nm] in flex | | | max. torque [Nm] in ext | | | flexor/extensor ratio | | | mean P [W] in flex | | | mean P [W] in ext | | |
|-----------|-----------------------------|-----|-----|----------------------------|-----|-----|-----------------------|------|------|-----------------------|-----|-----|----------------------|-----|-----|
| | CPM | ICM | IBM | CPM | ICM | IBM | CPM | ICM | IBM | CPM | ICM | IBM | CPM | ICM | IBM |
| means | 174 | 178 | 165 | 310 | 325 | 309 | 0.56 | 0.55 | 0.55 | 130 | 128 | 125 | 231 | 242 | 231 |
| ±SD | 42 | 37 | 40 | 58 | 62 | 77 | 0.10 | 0.06 | 0.12 | 32 | 36 | 35 | 46 | 51 | 63 |

DISCUSSION

Torque and power were not significantly different in the three modes, but the means differed by about 7 %, and in some single cases up to 20 %. Such discrepancies are not acceptable in research and performance testing. Studies and tests which do not use identical modes must be interpreted very carefully. For comparison between subjects, test conditions must be the same, i.e. identical position, contraction mode, ROM and speed. In the present study it was not possible for all athletes to reach the preset speed of 120°/s in ICM, because of the resistance of the testing device. Speed influences test results in isokinetic testing due to differential recruitment of muscle fibres. Lower speed settings would ensure that subjects reach the designated speed. Sport specific testing should measure with at least 120 °/s or faster. A ski jumper has a maximal angle velocity of about 200 °/s during take off, and speed skaters reach peak hip extension velocities of 425 °/s with conventional skates and 370 °/s with klapskates (Houdijk et al. 2000). Such high speeds cannot be achieved presently because of technical limitations and safety considerations. The limits of the Con-Trex trunk modul are set at 150 °/s for CPM and 200 °/s for ICM and IBM. In CPM mode the device provides the rhythm of the movement and moves the subject. This can result in problems in the analysis and interpretation of data if the timing or coordination of an athlete is not precise. The authors have recently seen eccentric flexions performed instead of concentric extensions and vice versa in movement patterns when the device changes direction. This has an influence on test results.

CONCLUSION

IBM is the most appropriate mode for testing athletes. IBM allows higher accelerations and higher velocities in movement. Isokinetic trunk tests should consider the specific of the different sports (ROM, speed, contraction mode) without losing sight of the athletes' safety.

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