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Journal de Traumatologie du Sport xxx (2016) xxx–xxx

JOURNAL DE TRAUMATOLOGIE DU SPORT

Original article

Influence of recovery time on strength during a testing protocol of knee

Effets du temps de récupération sur la force isocinétique du genou lors de tests d'évaluations

P.L. Bernard [a,*], P. Edouard [b], G. Tallon [a], S. Perrey [a], M. Billot [a], H. Blain [a,e], P. Codine [c], F. Degache [d]

[a] *Euromov, Montpellier university, 700, avenue du Pic-Saint-Loup, 34090 Montpellier, France*
[b] *Department of physical medicine and rehabilitation, LPE EA 4338 laboratory of exercise physiology, university hospital Saint-Etienne, 42005 Saint-Etienne, France*
[c] *Clinique "la Pinède", allée des Arts, 66240 Saint-Estève, France*
[d] *Institute of sport sciences (ISSUL), department of physiology, faculty of biology and medicine, university of Lausanne, Lausanne, Switzerland*
[e] *Department of internal medicine and geriatrics, Antonin-Balmes center, university hospital of Montpellier, 34090 Montpellier, France*

Abstract

The aim of the present study was to compare the influence of three rest intervals of 30, 60 and 180 seconds randomly applied between two sets of five isokinetic contractions of flexor-extensor knee muscles in a cohort composed of 14 men (32.5 ± 8 years). The comparison of the isokinetic values measured during the first set of each evaluation session showed no significant differences ($0.55 < P < 0.80$). The analysis of the time and rest interval interaction demonstrated no significant difference between the isokinetic measures obtained after the rest intervals for peak torque of the quadriceps and of the hamstrings and for the mean power of the quadriceps and the hamstrings. These findings raise questions about a strict energetic approach and a future research should analyze the interaction of force production and fatigue phenomena in relation to the rest interval.

Keywords: Recovery time; Isokinetic; Strength; Knee

Résumé

L'étude avait pour objectif de comparer l'influence sur la fonction musculaire de trois temps de récupération de 30, 60 et 180 secondes appliqués de manière randomisée et placés entre deux séries de cinq contractions isocinétiques des muscles fléchisseurs-extenseurs de l'articulation du genou chez 14 hommes sains (32,5 ± 8 ans). La comparaison des valeurs isocinétiques mesurées durant la première série de contractions de chaque séance d'évaluation montre une absence systématique de différence significative ($0{,}55 < p < 0{,}80$). L'analyse des interactions entre la session et le temps de récupération ne démontre aucune différence significative entre les valeurs isocinétiques de pic de couple et de puissance moyenne du quadriceps et des ischio-jambiers obtenues après application des trois temps de récupération. Ces données interrogent sur l'approche strictement énergétique et suggèrent une future étude portant sur les adaptations neuromusculaires et les interactions existantes entre les phénomènes de fatigue musculaire et de récupération.

Mots clés : Temps de récupération ; Isocinétisme ; Force ; Genou

1. Introduction

Several metabolic and neurophysiologic factors should be taken into account during muscular exercise in order to maximize strength output [1]. The management of exercise volume

* Corresponding author.
E-mail address: pierre-louis.bernard@umontpellier.fr (P.L. Bernard).

http://dx.doi.org/10.1016/j.jts.2016.07.005
0762-915X/

and intensity has been shown to have a significant impact on physical performance [2–4] and the ability to follow strength-training and rehabilitation programs, and helps to prevent the musculo-articular disorders caused by ill-adapted training [5].

The increasingly rational approach to training and evaluation, with a stronger foundation on scientific principles, has had a direct influence on how work and recovery times are balanced, particularly with regard to defining the recovery period within a work cycle. The twofold goal is to create the best conditions for muscular expression and to limit or delay fatigue through optimal rest periods [6,7]. The recoveries may be quite brief, with unit measures expressed in seconds or minutes, but they are nevertheless indispensable for managing all the factors affecting force output, such as H^+ ion accumulation, inorganic phosphate production, phosphocreatine (PC) depletion, and exercise-associated changes in excitation-contraction coupling [8–12]. The recovery is indeed one of the determinants in the success of health-maintenance or reconditioning programs. For maximal strength output, a recovery time is necessary to avoid the mobilization of energetic substrates that depend on anaerobic glycolysis and aerobic metabolism, as these lead to strength declines [13,14].

From a methodological perspective, isokinetic evaluations have used a wide variety of recovery times, ranging from some seconds to some minutes. Given this wide spread, the following question can be asked: How are recovery times set? Does age, gender, the health profile or disease influence a specific choice of recovery time?

Studies in the muscular training field have shown greater strength production with decreasing recovery times between sets in strength-building programs that lasted a few weeks. These data were presented by Rooney et al., [15] for a 6-week isotonic training program for biceps brachii and by Schott et al., [16] in a comparative study on the influence of 1 versus 2 minutes of recovery on quadriceps strength after 14 weeks of isometric training at 70% of maximal output, with three sessions per week. Bottaro et al. [17] showed that 30 seconds were sufficient for 20 elderly sedentary subjects to recover maximal strength in an isokinetic protocol at 60°/s. In an isokinetic protocol using five speeds ranging from low to high (60°/s to 300°/s), Parcell et al., [18] found that 60 seconds were sufficient for young healthy subjects to recover maximal strength for knee extensions.

In contrast, Robinson et al. [19] observed a significant development of strength output for a squat movement during a muscular program using 3 minutes versus 30 seconds of recovery. Pincivero et al. [20] showed a significant decrease in maximal knee torque in 15 young men during four sets of ten repetitions at 90°/s using 40 seconds of recovery between sets. They showed a 16% strength decrease between the first and fourth sets with a 40-s recovery but only a 2.2% decrease with a 160 seconds of recovery. Touey et al. [21] tested 28 young men over four sets of ten repetitions of isokinetic knee extensor movement at 60 and 180°/s and showed a decrease in peak torque with only 30 seconds and 60 seconds of recovery times between the sets.

The aim of this study was to determine the influence of recovery time on the isokinetic strength developed by the knee flexor-extensor muscles on the dominant side of healthy men.

2. Methods

2.1. Participants

The study cohort was composed of 14 men. The means and standard deviations of age, weight and height were, respectively, 32.5 years (± 8), 74.2 kg (± 10.3) and 177.5 cm (± 8.2). We excluded individuals involved in competitive sports or intensive training during the study period and those with chronic injury to the quadriceps or hamstrings or knee pathologies within the 12 months preceding the tests. We also excluded individuals with past surgery to the knee or lower limbs and those with cardiovascular disease and contraindications for physical activities and sports. All subjects gave their written informed consent to participate in the study.

2.2. Experimental procedures

The study protocol comprised three sessions of isokinetic knee movements on the dominant side separated by 48 hours. The warm-up and positioning on the dynamometer were the same in all sessions. After the warm-up, each session was composed of one set of five contractions at 90°/s, the application of the randomized rest interval (RI) of 30, 60 or 180 seconds, and a second set of five contractions at the same test speed.

2.3. Familiarization and testing

Before the isokinetic evaluation, each subject warmed up by ergocycling for 5 minutes with 60 watts of resistance and 90 rotations per minute, followed by 5 minutes of quadriceps and hamstring stretching.

We used the Biodex System 3® isokinetic dynamometer (Biodex Medical, Inc., Shirley, NY) from the Technological Platform of Euromov Center of Montpellier, France. The dynamometer was calibrated before every session, following the manufacturer's specifications. The quadriceps and hamstring muscles were evaluated in concentric/concentric modality with a 80° range of motion (ROM). The distal shin pad of the dynamometer level arm was attached 2–3 cm proximal to the lateral malleolus and motion ranged from 90° to –10° of knee extension in the sagittal plane to limit hamstring resistance during the extension. The cushion setting on the control panel for the hands of the ROM was set to the lowest (hard) setting during the evaluation in order to reduce the effect of limb deceleration on the reciprocal motion.

Tests were performed on the dominant side in the seated position with a hip flexion angle of 110°. Velcro straps stabilized the trunk and the thigh of the tested leg. The contralateral limb was not strapped. The resistance pad was placed 3 cm above the ankle joint and the dynamometer's axis of rotation was aligned with that of the knee joint. The hands were crossed over the trunk during testing.

Please cite this article in press as: Bernard PL, et al. Influence of recovery time on strength during a testing protocol of knee. J Traumatol Sport (2016), http://dx.doi.org/10.1016/j.jts.2016.07.005