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Effects of closed versus open kinetic chain knee extensor resistance training on knee laxity and leg function in patients during the 8- to 14-week post-operative period after anterior cruciate ligament reconstruction

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Abstract Open kinetic chain (OKC) knee extensor resistance training has lost favour in ACLR rehabilitation due to concerns that this exercise is harmful to the graft and will be less effective in improving function. In this randomized, single-blind clinical trial OKC and closed kinetic chain (CKC) knee extensor training were compared for their effects on knee laxity and function in the middle period of ACLR rehabilitation. The study subjects were 49 patients recovering from ACLR surgery (37 M, 12 F; mean age = 33 years). Tests were carried out at 8 and 14 weeks after ACLR with knee laxity measured using a ligament arthrometer and function with the Hughston Clinic knee self-assessment questionnaire and single leg, maximal

effort jump testing (post-test only). Between tests, subjects trained using either OKC or CKC resistance of their knee and hip extensors as part of formal physical therapy sessions three times per week. No statistically significant (one-way ANOVA, $p > 0.05$) differences were found between the treatment groups in knee laxity or leg function. OKC and CKC knee extensor training in the middle period of rehabilitation after ACLR surgery do not differ in their effects on knee laxity or leg function. Exercise dosages are described in this study and further research is required to assess whether the findings in this study are dosage specific.

Keywords Kinetic chain · Exercise · Quadriceps · Strength training

Introduction

In 1993, Yack et al. [33] drew the attention of orthopaedic surgeons and physical therapists to the fact that greater anterior tibial displacement (ATD) occurs during open than during closed kinetic chain resistance exercise of the knee extensors. Along with other work [2, 13], this study resulted in an increased research effort to compare these two forms of exercise. More importantly, the Yack et al. study [33] and related work led to a shift in clinical practice away from the use of knee extensor open kinetic chain (OKC) training towards closed kinetic chain (CKC) training in patients with injury or surgery of the anterior cruciate ligament (ACL).

This shift to CKC exercise was partly based on the assumption that the greater ATD believed to occur

during OKC exercise might lead to more pronounced permanent increases in knee laxity after a course of OKC training. This assumption can only be tested in clinical trials comparing the two regimens, which had not been done at the time. To further weaken the case for this assumption, Beynon and Fleming [4] have since shed doubt on whether the exercises actually differ in their strain on the ACL.

There were two other reasons for the changing bias towards CKC training. Firstly, because CKC exercises appear to better replicate functional tasks, they were thought to enhance functional performance to a greater extent than OKC exercises [24, 25, 28, 29, 31]. Secondly, it was believed that CKC exercise would be less harmful to the patellofemoral joint [31]. Again, however, these beliefs had not been tested in clinical trials.