

**Ettema, G, Weinrauch, P. & Kippers, V. (1996) Influence of hip rotation on coordination of isometric knee extensor exercises. In *Proceedings of 1996 Conference of the Anatomical Society of Australia and New Zealand*, page 14, Brisbane, Australia.**

### Introduction

Although the influence of hip flexion on knee extensor strength has been studied before, the effects of hip axial rotation, frequently used to produce specific effects in strength training, have been largely neglected. The purpose of this study was to examine the effects of hip rotation upon thigh muscle activation during isometric knee extensions in well trained strength athletes.

### Method

Five well trained young male strength athletes performed isometric knee extensions seated in an adjustable chair that stabilises the position of the trunk. With a T-bar inserted between the ankles, knee extension torques were recorded. For standardisation purposes, the subjects performed maximal voluntary isometric extensor torques (MVIET) at knee flexion angles of 90, 120 and 160 degrees. Subsequently, similar tasks were performed for three conditions of hip rotation: neutral, maximal medial rotation and maximal lateral rotation. To minimise the effects of fatigue, these exercises were performed at 50% MVIET for the respective knee angles. Surface EMG was used to monitor muscle activity. EMG was rectified, integrated, and normalized to the maximal EMG level obtained from all muscles in standardised maximal voluntary contractions. Photographs of the lower limb were taken in the frontal and sagittal plans to determine the actual knee and hip angles under which the trials were performed.

### Results

As a group, the quadriceps activity is only affected by knee angle. The IEMG activity of the quadriceps was around 50%, but differed widely from task to task (ranging from 56% to 32%). Considering the muscles of the quadriceps in isolation (Fig 1), it appears that the medial vasti muscles are responsible for the EMG dependence on knee angle. The vastus lateralis activity does not show any particular relationship with joint angles. The rectus femoris activity depended on the hip rotation angle, being higher in external rotation than other positions.

The adductor magnus activity depends on knee angle, the tensor fascia latae activity is enhanced at internal hip rotation up to 64%, and the biceps femoris (long head) showed activity levels ranging from 9% to 28%.

### Discussion

The activity of the obliquely oriented quadriceps muscle group is not affected by hip rotation. This result indicates that the quadriceps is active as a single, coordinated unit to exert the properly aligned force vector at the knee. However, the force alignment at the knee of the rectus femoris, the only quadriceps muscle crossing the hip joint, may be affected by hip rotation. Furthermore, the rectus femoris activity is influenced by hip rotation. Thus, apart from local effects at the hip, hip rotation may also affect rectus femoris activity because of implications at the knee. Changes in rectus femoris activity

may have been counterbalanced by the vasti group (including the vastus intermedius, which activity was not recorded).

External muscle torques that are produced during knee extension effort need to be in equilibrium at the hip. At all knee and hip positions, the external torque produced at the T-bar creates an extending moment at the hip. Thus, in net terms, hip flexor moments need to be produced to balance the required torque at the T-bar. Apart from the rectus femoris, the abductor magnus and the tensor fascia latae perform hip flexion (Dostal et. al., 1986) and thus may have helped in hip stabilisation. The actions of the long head of biceps femoris are antagonistic at both the hip and the knee in the performed task. No explanation was found for its relatively high activity of up to 28%, however co-contraction may have occurred for stabilising purposes.