

Effects of dynamic resistance training on fascicle length and isometric strength

LUIS M. ALEGRE¹, FERNANDO JIMÉNEZ¹, JOSÉ MANUEL GONZALO-ORDEN²,
RAFAEL MARTÍN-ACERO³, & XAVIER AGUADO¹

¹Facultad de Ciencias del Deporte, Universidad de Castilla-La Mancha, Toledo, ²Departamento de Patología Animal (Medicina Animal), Universidad de León, León, and ³INEF de Galicia, Universidad de Coruña, Coruña, Spain

(Accepted 12 May 2005)

Abstract

The aims of this study were to assess changes in muscle architecture, isometric and dynamic strength of the leg extensor muscles, resulting from dynamic resistance training, and the relationships between strength and muscle architecture variables. The participants ($n = 30$) were randomly assigned to one of two groups. The training group ($n = 16$; age 21.8 ± 2.3 years, body mass 74.8 ± 9.2 kg, height 1.75 ± 0.08 m) performed dynamic resistance training for 13 weeks. The control group ($n = 14$; age 19.9 ± 1.5 years, body mass 74.0 ± 8.5 kg, height 1.76 ± 0.05 m) did not perform any resistance training. Maximal dynamic and isometric strength were tested in both groups, before and after the training period. The members of the training group used the free-weight squat lift (90°) as their training exercise. The concentric phase of the squat was performed explosively. Skeletal muscle architecture of the vastus lateralis was visualized using ultrasonography. At the end of the study, significant increases in vastus lateralis muscle thickness ($+6.9\%$, $P < 0.001$), fascicle length ($+10.3\%$, $P < 0.05$), one-repetition maximum ($+8.2\%$, $P < 0.05$), rate of force development ($+23.8\%$, $P < 0.05$) and average force produced in the first 500 ms ($+11.7\%$, $P < 0.05$) were seen only in the training group. Adaptations to the muscle architecture in the training group limited the loss of fibre force, and improved the capacity for developing higher velocities of contraction. The architectural changes in the training group were similar to those seen in studies where high-speed training was performed. In conclusion, dynamic resistance training with light loads leads to increases in muscle thickness and fascicle length, which might be related to a more efficient transmission of fibre force to the tendon.

Keywords: Pennation, biomechanics, vastus lateralis, fascicle length, resistance training, isometric strength

Introduction

The response of skeletal muscle to resistance training is commonly associated with an increase in muscle mass, neural adaptations and increases in force-generating capacity. A muscle's architecture has been reported to influence its contraction properties, because fibre length and pennation angle are closely associated with differences in muscle shortening velocity (Wickiewicz, Roy, Powell, Perrine, & Edgerton, 1984). Therefore, adaptations to different resistance training programmes might be modulated by the muscle architecture changes specific to each.

Several longitudinal studies have been conducted on the influence of resistance training on muscle architecture (Aagaard *et al.*, 2001; Blazevich, 2000; Blazevich, Gill, Brooks, & Newton, 2003; Blazevich & Giorgi, 2001; Kanehisa *et al.*, 2002; Kawakami, Abe, Kuno, & Fukunaga, 1995; Rutherford & Jones,

1992). It has been demonstrated that specific regimes of training or physical activity evoke changes in fibre pennation angle. The most common changes resulting from heavy resistance training are increases in muscle thickness, pennation angle and cross-sectional area (CSA) (Aagaard *et al.*, 2001; Blazevich & Giorgi, 2001; Kawakami *et al.*, 1995; Narici, 1999). However, other studies have reported no changes or even decreases in pennation angle after a period of resistance training (Blazevich & Giorgi, 2001; Blazevich *et al.*, 2003; Rutherford & Jones, 1992). These inconsistencies could have resulted from differences in training load and velocity-specific adaptations (Blazevich *et al.*, 2003).

It is unclear how lighter training loads than those used in previous studies could affect muscle architecture, and few studies have correlated muscle architecture with performance in sprint or strength tests (Abe, Fukashiro, Harada, & Kawamoto, 2001;