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## Original research

## A comparison in the muscle activity of the abductor hallucis and the medial longitudinal arch angle during toe curl and short foot exercises

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## ABSTRACT

**Objective:** To compare the muscle activity of the abductor hallucis (AbdH) and the medial longitudinal arch (MLA) angle during toe curl (TC) and short foot (SF) exercises while sitting or in one-leg standing position.**Design:** Two-way repeated-measures ANOVA was used to analyze the effects of exercise type and position on the muscle activity of the AbdH and the MLA angle.**Participants:** Twenty subjects with normal feet participated in this study.**Main outcome measures:** The muscle activity of the AbdH and the MLA angle were measured during TC and SF exercises while sitting or in one-leg standing position.**Results:** The EMG activity of AbdH in SF exercise was significantly greater than during TC exercise in both exercise postural positions ( $p < 0.001$ ). During the SF exercise, the EMG activity of the AbdH in the one-leg standing position was significantly higher than that while sitting ( $p < 0.001$ ). The MLA angle in SF exercise was significantly smaller than during TC exercise in both postural positions ( $p < 0.001$ ).**Conclusions:** These results suggest that SF exercise is a more useful strengthening exercise than TC exercise in activating the AbdH muscle.

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## 1. Introduction

Pronation is a complicated triplanar motion of the foot. It is a critical motion that contributes to shock absorption from ground reaction forces and to the attenuation of the forces transmitted to the body during normal gait (Franco, 1987; Nack & Phillips, 1990). However, excessive pronation is associated with several overuse injuries, including plantar fasciitis (Pohl, Hamill, & Davis, 2009), hallux valgus (Easley & Trnka, 2007), Achilles tendonitis (Clement, Taunton, & Smart, 1984; Ryan, Grau, Krauss, Maiwald, Taunton, & Horstmann, 2009), tibialis posterior tendon dysfunction (Tome,

Nawoczenski, Flemister, & Houck, 2006), and patellofemoral pain syndrome (Powers, Maffucci, & Hampton, 1995).

The bony structures, ligamentous support, and extrinsic and intrinsic foot muscles control excessive pronation and maintain the medial longitudinal arch (MLA) during weight-bearing activities. Among the five midtarsal bones, the navicular serves as the keystone of the MLA (Franco, 1987). Various ligaments have been shown to maintain this structural integrity, including the deltoid ligament (Kitaoka, Luo, & An, 1998), plantar fascia (Cheung, Zhang, & An, 2004), and spring ligament (Borton & Saxby, 1997; Jennings & Christensen, 2008). Extrinsic muscles, including the anterior (Murley, Menz, & Landorf, 2009; O'Connor & Hamill, 2004) and posterior tibialis (Murley et al., 2009; O'Connor & Hamill, 2004) and the peroneous longus muscles (O'Connor & Hamill, 2004; Van Boerum & Sangeorzan, 2003), assist to stabilize the midtarsal joint and provide dynamic support to the MLA during stance phase. Various intrinsic foot muscles, such as the abductor hallucis, flexor digitorum brevis, and interosseous, contribute to stabilize the foot

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