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Muscle imbalance and reduced ankle joint motion in people with hammer toe deformity

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ABSTRACT

Background: Multiple factors may contribute to hammer toe deformity at the metatarsophalangeal joint. The purposes of this study were to (1) compare the ratio of toe extensor/flexor muscle strength in toes 2–4 among groups with and without hammer toe deformity, (2) to determine correlations between the ratio of toe extensor/flexor muscle strength in toes 2–4, and metatarsophalangeal joint deformity (3) to determine if other clinical measures differ between groups and if these measures are correlated with metatarsophalangeal joint angle.

Methods: Twenty-seven feet with visible hammer toe deformity and 31 age matched feet without hammer toe deformity were tested. Toe muscle strength was measured using a dynamometer and the ratio of toe extensor muscle strength to flexor muscle strength was calculated. Metatarsophalangeal joint angle was measured from a computerized tomography image. Ankle and subtalar joint range of motion, and tibial torsion were measured using goniometry.

Findings: Extensor/flexor toe muscle strength ratio was 2.3–3.0 times higher in the hammer toe group compared to the non-hammer toe group, in toes 2–4. The ratios of extensor/flexor toe muscle strength for toes 2–4 and metatarsophalangeal joint angle were highly correlated ($r = 0.69 - 0.80$). Ankle dorsiflexion and metatarsophalangeal joint angle were negatively correlated for toes 2–4 ($r = -0.38$ to -0.56) as were eversion and metatarsophalangeal joint angle.

Interpretation: These results provide insight into potential risk factors for the development of hammer toe deformity. Additional research is needed to determine the causal relationship between hammer toe deformity and the ratio of toe extensor/flexor muscle strength in toes 2–4.

1. Introduction

A hammer toe deformity is defined as dorsiflexion at the metatarsophalangeal joint (MTPJ), plantarflexion at the proximal interphalangeal joint and either normal position or dorsiflexion at the distal interphalangeal joint (Tollafild and Merriman, 1995). Hammer toe deformity is a common problem particularly in the second toe and can be a source of discomfort in the forefoot (Dhukaram et al., 2002). The incidence of hammer toe deformity increases with age. Hammer toe deformity may cause pain and callus over the proximal interphalangeal joint due to irritation from shoe wear, and may also cause metatarsalgia and callus formation under the metatarsal head. Hammer toe deformity is common in people with diabetes and peripheral neuropathy and is associated with increased forefoot plantar pressure and increased risk of ulceration (Lavery et al., 1998; Mueller et al., 2003).

Potential risk factors for hammer toe deformity are diverse and include (among others) muscular imbalance, ineffectiveness of the toe flexors (atrophy and weakness of intrinsic muscles of the foot), hallux valgus, trauma, inflammatory arthritis, contracted extensor digitorum longus (EDL), diabetes, foot type and biomechanical factors (Coughlin, 1984; Coughlin et al., 2000; Dhukaram et al., 2002; Parrish, 1973; Hansen, 2000). Muscle imbalance between the toe extensors and intrinsic toe flexors has been considered a primary cause for some types of hammer toe deformity (Scheck, 1977; Schnepp, 1937; Hansen, 2000). The strong extension forces of the EDL and extensor digitorum brevis (EDB) muscles at the MTPJ are balanced by the flexor digitorum longus, interosseus and lumbrical (intrinsic foot muscles) muscles (Bhatia et al., 1994). When the intrinsic muscles of the foot are weak, the prolonged unopposed action of the extensor muscles is believed to cause hammer toe deformity (Boulton, 1988). However, a recent study in people with

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