

Case Study

# Effect of the Intrinsic Foot Muscle Exercise Combined with Interphalangeal Flexion Exercise on Metatarsalgia with Morton's Toe

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**Abstract.** [Purpose] This study examined the effects of the intrinsic foot muscle exercise combined with interphalangeal flexion exercise on metatarsalgia with Morton's toe. [Subject] A 38-year-old male with Morton's toe, who complained of pain in his left metatarsophalangeal joints was the subject. [Methods] The pressure pain threshold, peak contact pressure of the metatarsophalangeal region during gait, and the navicular drop were measured before and after the intrinsic foot muscles exercises combined with interphalangeal flexion exercise. [Results] After exercising for 2 weeks, the pressure pain threshold increased from 1 to 1.5 kg, while the peak contact pressure decreased from 0.63 to 0.50 kg/cm<sup>2</sup>, and the navicular drop improved from 5 to 8 mm. [Conclusion] The results show that the combined exercises alleviated the pain while walking by reducing the excessive pressure on the metatarsophalangeal region, and the improvement of gait with Morton's toe.

**Key words:** Contact pressure, Interphalangeal flexion, Metatarsalgia

(This article was submitted Apr. 7, 2014, and was accepted Jun. 12, 2014)

## INTRODUCTION

Metatarsalgia is pain in the region of the metatarsophalangeal joints<sup>1)</sup>. In one study, the use of orthotic insoles did not prevent lower limb discomfort related to physical stress in young males and orthotic insoles were not recommended<sup>2)</sup>. Another study found no significant differences in maximum pronation, calcaneal eversion, or total pronation of the foot with the use of various types of arch support<sup>3)</sup>. Others, recent studies have investigated correction of deformed feet using muscle strengthening and a number of studies have used muscle-strengthening exercises to facilitate formation of the arch of the foot<sup>4, 5)</sup>. Most general intrinsic-foot-muscle-strengthening exercises are performed with the toes extended fully<sup>5, 6)</sup>. However, few studies have used muscle-strengthening exercises to prevent foot deformation in patients with Morton's toe. Therefore, this study examined the effects of the intrinsic foot muscle exercise combined with interphalangeal flexion exercise on metatarsalgia with Morton's toe.

## SUBJECT AND METHODS

A 38-year-old male with Morton's toe, who complained of pain in his left metatarsophalangeal joints was the sub-

ject. The navicular drop test was performed to determine the neutral foot alignment range (5–9 mm). He scored 5 mm in the navicular drop test. Approval for this study was granted by Inje University Faculty of Health Science Human Ethics Committee, and the subject gave his informed consent before participating in this study. A dolorimeter (Fabrication Enterprises, White Plains, NY, USA) was used to measure the pressure pain threshold in the left metatarsophalangeal region. Before making measurements with the pressure dolorimeter, the subject was instructed to indicate when he began to feel pain. The reliability of the pressure pain threshold measurements exceeds 80%. The initial pressure pain threshold was 1 kg. The peak contact pressure in the left metatarsophalangeal region while walking was measured using the CONFORMat System (Model #5330, Tekscan, Boston, MA, USA), a portable interface pressure-mapping system that captures the foot pressure distribution and contact area. The navicular drop test was performed using the modified Brody method while weight bearing<sup>7)</sup>. The clinician touched the lateral and medial talar domes with his thumb and index finger, and the subject moved slowly to generate inversion and eversion. When the subtalar joint was in the neutral position, the clinician measured the distance between the navicular tubercle and floor in millimeters. The pressure pain threshold, peak contact pressure in the metatarsophalangeal region while walking, and navicular drop after performing the intrinsic foot muscle exercises combined with the interphalangeal flexion exercise were measured. The subject performed both exercises with both feet. The first exercise was forefoot adduction with flexion of the interphalangeal joint. With the subject in a long sitting position, the heel was held, and pressure

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applied to the first metatarsal and interphalangeal joint in the area around the inner pressure, with flexion of the interphalangeal joint<sup>4, 5</sup>). This position was maintained for 5 s. The second exercise was a short foot exercise with flexion of the metatarsophalangeal joint. The subject flexed the hip and knee at 90° while sitting on a chair. The metatarsal was drawn toward the heel with flexion of the interphalangeal joint<sup>4, 5</sup>). This position was maintained for 5 s. The subject performed each exercise 50 times per day for 2 weeks under the guidance of a physical therapist.

## RESULTS

After exercising for 2 weeks, the pressure pain threshold increased from 1 to 1.5 kg, while the peak contact pressure decreased from 0.63 to 0.50 kg/cm<sup>2</sup>, and the navicular drop improved from 5 to 8 mm.

## DISCUSSION

The study subject was a patient with metatarsalgia with relatively low foot arches and symptoms of Morton's toe. As metatarsalgia is closely related to the arch of the foot<sup>6</sup>), formation of an appropriate arch is a priority for patients with this condition. The medial longitudinal arch is supported by the shape of the foot bones, the long and short plantar ligaments, plantar aponeurosis, and plantar muscles and tendons<sup>8</sup>). The plantar muscles are classified into extrinsic and intrinsic muscles. Extrinsic foot muscles assist in stabilizing the midtarsal joint and provide dynamic support to the medial longitudinal arch during the stance phase<sup>9</sup>). The intrinsic foot muscles contribute to foot arch stability during propulsion<sup>10</sup>). Morton's toe is a condition involving a shortened first metatarsal relative to the second metatarsal, and is often a precursor of musculoskeletal pain associated with excessive pronation of the foot<sup>10</sup>). As a new method of treating metatarsalgia, we combined an exercise to strengthen the intrinsic foot muscles with flexion of the interphalangeal joints. We consider the intrinsic-foot-muscle-strengthening exercise raised the arch of the foot, thereby minimizing the stress on the metatarsophalangeal joints, that flexion of the

interphalangeal joints alleviated metatarsalgia by strengthening the flexors of the metatarsophalangeal joints, thereby preventing excessive extension of the joints. We think that combining these two exercises limited the posterior shear force in the metatarsophalangeal joints while walking. In addition, the navicular drop improved after exercising for 2 weeks. A previous study showed that strength training of the foot intrinsic flexors improved muscle strength, foot arch shape, and movement performance<sup>11</sup>). In conclusion, this study showed that the combined exercises alleviated the pain while walking by reducing the excessive pressure on the metatarsophalangeal region, and improvement of gait with Morton's toe.

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