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The Relationship between Activity of Abductor Hallucis and Navicular Drop in the One-leg Standing Position

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Abstract. [Purpose] This study examined whether abductor hallucis (AH) activity in the one-leg-standing position can be used to predict the navicular drop (ND) when it is or is not actively supporting the medial longitudinal arch. [Subjects] Forty healthy subjects without foot or ankle problems were recruited. [Methods] For all subjects, the ND was measured as the difference in navicular height between the subtalar joint resting (STJR) and subtalar joint neutral (STJN) positions while standing. AH activity was measured in both positions during one-leg standing. [Results] AH muscle activity in the STJR position was significantly negatively correlated with the ND, while AH muscle activity in the STJN position was not. Using a simple regression model, AH activity predicted the ND based on the STJR position. [Conclusion] The results suggest that AH activity is a good predictor of the ND. Therefore, intervention that activates the AH in the one-leg standing position could be used to correct the ND.
Key words: Abductor hallucis, Navicular drop, Foot pronation

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INTRODUCTION

Foot pronation is a complicated but critical triplanar movement that absorbs the shock from ground reaction forces[1, 2]. However, excessive pronation (pes planus) is a chronic condition caused by insufficient support of the medial longitudinal arch (MLA) of the foot[3–5]. An excessively pronated foot is associated with several clinical pathologies of the lower extremity, including plantar fasciitis, tibialis posterior tendinitis, Achilles bursitis or tendinitis, and patellofemoral pain syndrome[6–9].

While weight-bearing, the bony structures, ligaments, and extrinsic/intrinsic foot muscles contribute to maintaining the MLA of the foot to control excessive pronation[10–13]. Of the midfoot bones, the navicular supports the structures of the MLA[14, 15]. Consequently, direct measurement of the navicular displacement in a weight-bearing position is one of the simplest methods for providing clinically quantifiable information regarding pronation of the foot[16–18]. Clinically, navicular displacement in a weight-bearing position is measured using the navicular drop (ND) test.

The intrinsic foot muscles, including the abductor hallucis (AH), flexor hallucis brevis, and interosseous, contribute to stabilization of the foot arch during locomotion[19, 20]. Of these, the AH is the medial-most muscle in the first layer of intrinsic muscles at the plantar surface of the foot. Many studies have reported that the AH plays an important role in supporting the MLA and works in conjunction with elevation of the MLA[21–23]. Moreover, blocking the tibial nerve, which controls the activity of the AH, produces a significant increase in pronation as assessed by the ND test[21]. Therefore, the literature suggests that strengthening the AH would help to elevate the MLA.

Although previous studies have reported that the AH helps support the MLA[22–25], no study has examined the relationship between AH activity and the ND during one-leg standing. Therefore, this study investigated the correlation between the AH and ND and the ability to predict the ND from AH activity, while actively supporting the MLA during static one-leg standing.

SUBJECTS AND METHODS

Forty-nine subjects were recruited and the ND of each was measured. Mueller suggested that an ND > 10 mm in the pronated foot is pathological[14, 17]. The exclusion criteria were: a history of lower extremity surgery; foot and ankle injury within 6 months of participation; previous or current inflammatory arthritis; diabetes; severe foot deformities such as hallux valgus, hammer toe, and claw toe; rigid foot with an ND < 3 mm; and an inability to actively support the MLA. After excluding nine subjects, the remaining forty participated in this experiment. All subjects provided their written informed consent before participating, and the study was approved by the Institutional Review Board of Yonsei University Wonju Campus.