J. Phys. Ther. Sci.
27: 1257–1260, 2015

Original Article

Effect of treadmill walking with ankle stretching orthosis on ankle flexibility and gait

Young-ki Cho, MS, PT[1, 2], Si-hyun Kim, PT, PhD[2], In-cheol Jeon, MS, PT[2], Sun-hee Ahn, BHSc, PT[2], Oh-yun Kwon, PT, PhD[2]*

[1] *Department of Rehabilitation Medicine, Asan Medical Center, University of Ulsan College of Medicine, Republic of Korea*
[2] *Department of Physical Therapy, Graduate School, Yonsei University: 234 Maeji-ri, Heungeop-Myeon, Wonju, Kangwon-do 220-710, Republic of Korea*

Abstract. [Purpose] The purpose of this study was to evaluate the kinematics of the ankle in the lunge to establish effectiveness of an ankle stretching orthosis (ASO) on the ankle dorsiflexion range of motion (ROM) of individuals with limited dorsiflexion ROM. [Subjects and Methods] Forty ankles with decreased dorsiflexion ROM of 20 participants were evaluated in this study. After wearing the ASO, participants walked on a treadmill for 15 minutes. Participants walked on the treadmill at a self-selected comfortable speed. Ankle dorsiflexion ROM, maximum dorsiflexion ROM before heel-off, and time to heel-off during the stance phase of gait were measured before and after 15 minutes of treadmill walking with the ASO. The differences in all variables between before and after treadmill walking with ASO were analyzed using the paired t-test. [Results] Ankle active and passive ROM, and dorsiflexion ROM during lunge increased significantly after treadmill walking with ASO. Treadmill walking with the ASO significantly increased the angle of maximal dorsiflexion before heel-off and time to heel-off during the stance phase. [Conclusion] The results of this study show that treadmill walking with the ASO effectively improved ankle flexibility and restored the normal gait pattern of the ankle joint by increasing dorsiflexion ROM, maximal angle of dorsiflexion, and time to heel-off in the stance phase.

Keywords: Ankle stretching orthosis, Ankle dorsiflexion range of motion, Gait

(This article was submitted Oct. 24, 2014, and was accepted Jan. 7, 2015)

INTRODUCTION

Normal flexibility of the ankle joint is necessary for functional activities such as gait[1]. Limited ankle joint dorsiflexion range of motion (ROM) can cause altered foot position and compensatory movement leading to musculoskeletal pain and lower extremity overuse injuries, as well as an abnormal gait pattern[2]. For normal walking, adequate dorsiflexion ROM is necessary to contribute to the distribution of the body weight during the stance phase of walking[3]. Adequate dorsiflexion motion at the talocrural joint is necessary for normal functional activities of ankle joint, such as walking, running, jumping and many other weight-bearing activities. A minimum of 10° of dorsiflexion is required for walking, and 30° is needed for running[4]. Jordan et al.[5] reported that the ankle joint dorsiflexes 4° to 10° beyond neutral during the stance phase of walking, and maximal dorsiflexion occurs just before heel-off. Insufficient talocrural dorsiflexion increases risk factors of gait impairments during walking and running[4]. Limited ankle dorsiflexion ROM during knee extension could result in compensatory changes during walking, such as earlier time to heel off, increased pronation, and midtarsal joint dorsiflexion[6]. A previous study showed that participants with limited ankle dorsiflexion ROM showed earlier heel-off than individuals with normal ankle dorsiflexion[7]. Early heel-off may increase the time of weight-bearing on the forefoot during the stance phase of gait, resulting in ankle and forefoot injuries[8]. Repetitive abnormal loading on the forefoot may cause various injuries, such as plantar fasciitis, achilles tendinitis, and ankle sprain.

Insufficient length of the gastrocnemius muscle, soleus muscle, and the achilles tendon and abnormal joint structures of the talocrural joint contribute to limited ankle dorsiflexion ROM[4]. Tightness of the calf muscles could impede the progression of the tibia on the talus, which favors the occurrence of an excessive compensatory pronation of the subtarlar joint during gait[9, 10]. Various techniques have been used for increasing ankle dorsiflexion ROM to prevent biomechanical change during gait and overuse injuries in rehabilitation and sports. Ankle dorsiflexion ROM can be increased via a variety of training and clinical techniques such as muscle stretching, mobilization with movement (MWM), and talus-stabilizing taping (TST).

A new Ankle Stretching Orthosis (ASO) was designed to stretch the ankle joint during walking. The ASO is a modification of the University of California Berkley Laboratory

*Corresponding author. Oh-yun Kwon (E-mail: kwonoy@yonsei.ac.kr)