

CUSTOMIZED WEARABLE SENSOR-BASED INSOLES FOR GAIT RE-TRAINING IN IDIOPATHIC TOE WALKERS

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ABSTRACT

Idiopathic toe walking is associated with lack of heel strike during the initial contact phase of a gait cycle. Idiopathic toe walking affects 5-12% of healthy children in the US. In the case of idiopathic toe walkers: typically, a child can heel-toe walk, but habitually walk on their toes. A corrective intervention is needed during the early age of a child. In this pilot study, we developed a wearable insole with tactile corrective feedback. A total of five subjects (13±4 years) participated in this study. A customized insole was designed with two pressure sensors, inertial measurement units, a vibration motor and on-board data storage SD card. A vibration biofeedback was provided to the participants if three consecutive toe-toe strikes were found while walking. We found that the average proportion of heel to toe strikes was 0%,66%,64%,53% and 67 % among participants. We also found median time of return to habitual walk of toe-toe gait was 13 seconds. All analysis was conducted on a walking data ranging from 2 to 20 hours of walking. All five subjects reported that the customized insoles were helpful and motivated them for a corrective gait. This novel research with wearable sensors will help physical therapists to utilize innovative intervention methods for gait training in idiopathic toe walkers.

Keywords: Idiopathic Toe Walkers, gait, wearable insoles, factors, toe-toe gait, heel-toe gait

INTRODUCTION

Idiopathic toe walking can be described as bilateral toe walking with no orthopedic or neurological cause past the age of two years. In this condition, children can voluntarily walk with the normal heel-toe pattern but habitually prefer to walk with the toe-toe pattern for unknown reason[1]. In order for it to be considered idiopathic, the child's medical history should be clear of any neurological, orthopedic, or neuro- psychiatric conditions including other gait abnormalities. Idiopathic toe walking affects 5-12% of healthy children in the US[1, 2]. Children with idiopathic toe-walking have developmental delays and neurodevelopmental diagnoses[3-6]. Several invasive interventions are adopted if the child does not grow out of the toe walking behavior, such as leg braces, serial casting, botox, surgical lengthening of the Achilles tendon[2]. A few studies have explored long-term gait outcomes of toe walking (>5 years) following treatment in childhood [7-10] but are limited in sample size.

Idiopathic toe walkers usually walk subconsciously on their toes and when alerted can produce heel-toe gait. In order to bring heel-toe gait the physicians recommend the parents to watch their children when walking on toes and correct them. Although this practice helps in reducing toe-toe gait in daily life, but automated biofeedback-based interventions are needed to change toe walking behavior in the adolescents. In this study, we have developed a new non-invasive method of correcting toe walking behavior through corrective tactile biofeedback. This method is non-invasive and can be easily and safely incorporated in the life of toe walkers. This can also be used as corrective intervention tool for treatment by pediatric physical therapists. In this study, we have investigated into feasibility of customized wearable sensor-based insoles for gait re-training in idiopathic toe walking adolescents.