Effects of the pneumatic gait assist system on the lower extremity muscles during walking using superficial EMG

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Abstract—Pneumatic wearable walking support device (PWWSD) is especially designed to increase performance in repetitive gaiters such as factory workers. The support of the device in the lower extremities was measured by evaluating myoelectric signals obtained from the EMG measurement on leg muscles during the gait cycle swing phase. Twelve male volunteers were measured three times from right side of the body on the treadmill, at the speed of 2.5 km/h for 2 minutes, without/with device, device-off and device-on. When the device was running – in device-on mode-, there was a decrease in Rectus Femoris (RF) muscle mean amplitude of 3 volunteers as a result of superficial EMG, an increase in mean amplitude in the remaining 9 volunteers, a decrease in 7 volunteers in the mean amplitude of Vastus lateralis (VL) muscle, and an increase in 5 volunteers. In 2 volunteers, the mean amplitudes of both muscles measured were reduced during instrument use (device-on mode). It was seen that the PWWSD supported these two muscles, which play a key role in movement the thighs and legs, in the swing phase of the gait cycle during device-on mode. In conclusion, the performance can be maintained constantly by adjusting such as thigh-leg size, person weight, and thigh-leg thickness parameters or considering walking habits of the person in the design of such devices and providing the necessary ergonomics by using a flexible and light material in the structure of the device.

Keywords—Wearable walking helper; Pneumatic system; EMG measurement

I. INTRODUCTION

Nowadays, auxiliary mechanisms are gaining importance due to the increase of the elderly population and the current working conditions. Especially, gait ability is the most necessary functional movement during life. For this reason, except for wheeled systems, systems which will make it easier to step are needed. Many researchers have invented and developed walker-type support system. In this study, A PWWSD is specially designed to increase efficiency for the factory walkers during the swing phase of walking and measured the efficiency of PWWSD on the subjects. The main aim of this study is to evaluate the myoelectric signals obtained by superficial EMG measurement during walking and to have knowledge about the support of PWWSD to the lower extremity muscles, to create the groundwork for new studies to be done in this topic.

II. MATERIAL AND METHODS

A pneumatic cylinder and its valves were mounted on a post-op knee brace with aluminum bar. Then the device was fitted to the subjects. Three measurements from the volunteers were performed from VL and RF muscles in the right thigh region for 2 minutes on the treadmill. In all measurements, the walking speed was set at 2.5 km/h to provide pneumatic piston activation of the PWWSD. The first measurement was performed without the PWWSD, while the second measurement was performed with device attached, but pneumatic piston was inactive in device-off mode in order to observe the effect of the weight of the apparatus and the adjustment points of the volunteer. The third measurement was made while the device was active in device-on mode. Superficial EMG measurements were performed by a 4-channel Biopac MP36R instrument and the results obtained by comparing the mean amplitudes of the myoelectric signals produced by the muscles using the Biopac Student Lab 4.0 software were evaluated.

III. RESULTS AND DISCUSSION

The myoelectric signals of RF and VL muscles of the 3 volunteers resulted in a reduction in the mean amplitude of RF and an increase in mean amplitude of the remaining 9 volunteers. In the mean amplitude of VL, a decrease was seen in 7 volunteers and an increase was seen in 5 volunteers. During the use of the PWWSD in 2 volunteers, the mean amplitudes measured in both muscles decreased together. The PWWSD supports the RF in 4 volunteers and the VL in 5 volunteers in device-off mode. That means the average amplitudes of the muscles decreased in both muscles of these 4 volunteers. In device-on mode, RF muscle of 2 volunteers and VL muscle of 5 volunteers were supported by the PWWSD. It was seen that there was no device support in the remaining measurements. The severity of PWWSD is thought to result in different outcomes in different volunteers due to restricting hip-knee movements during the walking cycle. So, it is considered that the necessary ergonomics should be provided.