DEVELOPMENT OF AN ACTIVE BODY WEIGHT SUPPORT SYSTEM CONSIDERING A GAIT PATTERN; COMPUTATIONAL STUDY

Sungyoon Jung, Sungjae Kang, Hyunseok Cho, Gyoosuk Kim, Jeicheong Ryu, Museong Mun, Chang-Yong Ko*

Korea Orthopedics and Rehabilitation Engineering Center (KOREC), Republic of Korea

Introduction

Gait training is of importance to enhance and improve the health, functional daily activity, and fitness of the patients with spinal cord injury and the elderly, leading to improvement of quality of life. Up to date, usage of treadmill system has been suggested as one of the most effective gait training methods. However, it is difficult to directly administer gait training using treadmill system to such subjects due to lack of ability of mobility independently. Recently, a body weight support (BWS) system has been considered as an essential component in a gait training using treadmill and can support an upright posture and reduce joint forces on the subjects. The BWS systems were categorized as two types according to the counterbalancing methods, a passive type versus an active type [Lee, 2003]. However, there were several limitations in the existing BWS system, impossibility of controlling the load applied on the patients during gait training in passive types and nose in active types using a pneumatic actuator. This study, thus, aimed to design new BWS system considering a gait pattern through computational study. Furthermore, we compared with new BWS system and the existing passive ones.

Methods

Computational models of new system (Fig. 1) and the existing systems were drawn and were analyzed by Recurdyn^{TM} (FunctionBay GmbH, Germany). These models consisted of the BWS systems and a virtual human dummy. In new system, the BWS system was characterized as a combination of passive and active systems. An elastic spring at an 8mm of diameter, 140mm of strain length, 400mm of total length, and 27.67N/mm of spring coefficient was used in the passive systems. In the active systems, load control motor at 1,000watt and sensor of load applied on the patients during gait training were used. Such systems play a critical role in controlling the load applied on the patients during gait training. Additionally, a tow motor at 200watt to tow the subjects on the BWS system and weight measurement sensor for measuring subject`s weight were used. The virtual human dummy consisted of fourteen joints and fifteen rigid bodies and was set as 80kg of weight and 178cm of height.

Gait pattern was acquired from a subject (80kg, 178cm) via a motion capture system (Motion analysis Ltd, USA). Then this pattern was applied to new and the existing systems. Concurrently, the load applied on the subject was set as 300N corresponding to 37% of body weight, which is within clinical gait therapy in the early phase ranging from 20% to 40% [Frey, 2006]. Finally the values of load measurement sensor were measured.

Results

Fig. 2 shows the computational simulation results. In new system, the load was ranging from 240N to 320N. However, the loads in the previous systems were ranging from 180N to 460N. Because targeting offloaded load (body weight) was 37%, our system could offload on 29%~39% of body weight, while the previous system offloaded on 23%~56% of body weight.

Discussion

These results indicated that our system could effectively reduce and preciously/accurately control the load applied on the patients during gait training compared to the previous systems.

In this study, we performed only computational studies. Therefore, we are currently integrating the BWS system based on the present results and investigating clinical trials in an ongoing study.

References

Frey *et al*, IEEE Trans. Neural Syst. Rehabil. 14: 311-321, 2006

Lee *et al*, Int. J. Human-Friendly Welfare Robot. Syst., 4:42-46, 2003.

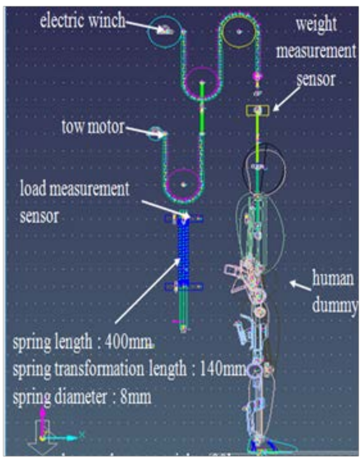

Figure 1: Computational model of the proposed BWS system

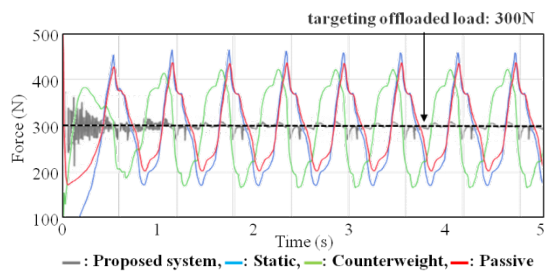

Figure 2: Results of computational simulation