9F-15 高齢親和用品の設計にあたり乗下降駆動パターンによる使用者の 生体力学的な特性に関する研究

A Study on the Biomechanical Characteristics of Users due to Lifting Speed Patterns in Design Process of Senior-friendly Products

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1. Introduction

Recently, Korea has already become an aging society (aging population over 65 years: 7%) in 2000 and the number of people aged over 65 is expected to reach approximately 40% of its population by 2050 (2006 Statistical Report of Ministry of Health and Welfare in Korea). Approximately 4% of the elderly with a disability grade 1 or 2 are cared for by caregivers or are accommodated in care facilities (Fig. 1). In general, four major elements of activity of daily life (ADL) for the elderly are eating, bathing, defecating, and indoor moving (2008 Survey of Living Conditions of the Elderly, the Ministry of Health and Welfare, Korea).

For caregivers to efficiently respond to the needs of the elderly, various senior-friendly products such as lifts, carriers, shower carriers are required. Generally, products for the indoor care of the elderly are equipped with lifting modules for the safe movement of the elderly. In developing lifting modules, it is essential to perform an optimal design by examining the biomechanical characteristics of users according to driving conditions. However, adequate R&D related to the system has not been sufficiently performed. This study fabricated a testing device for a lifting module used for a lift or a shower carrier, and measured the biomechanical characteristics of the user by performing a lifting test according to various speed patterns, and examined the results.

2. Study Method

2.1 A lifting Module Testing Device

This study fabricated a lifting module testing device as a rigid body type to neglect local deformations, and determined the overall size using the body information on Koreans in their sixties (Size Korea, 2004). The bed length was set at 2,000mm considering the maximum height (1,816mm) of the elderly in their sixties. The bed width was set at 1,000mm considering the width (507mm) between the arms and the average width of the left and right hands (80.7mm*2) of the elderly in their sixties. Maximum allowable force was set at min. 2,500N considering the user's weight and that of the structure. The bed stroke was set at a maximum 500mm for the lifting test (Fig. 2).

Fig. 1 Summary of Life Style Pattern of the Elderly in Korea

Fig. 2 Test Equipment with Lifting Module

Fig. 3 Five Types of Lifting Speed Patterns for Measuring Body Pressure and Contact Force

2.2 Speed Patterns of a Lifting Module

This study selected five types of speed patterns (linear acceleration, maintenance of linear motion, triangular pattern, trapezoidal pattern, sine curve pattern) of the lifting module applied to the testing device (Fig. 3). In addition, this study performed lifting tests by setting the time taken for the stroke to reach the maximum 500mm within 17 seconds and 30 seconds for each speed pattern, and examined the change in biomechanical characteristics between the two lifting time conditions of 17 and 30 seconds.

2.3 Body Pressure Measurement Device and Subjects

This study used a body pressure mattress (2.0m*1.0m, Novel, Germany) to examine the change in contact force and contact pressure between the user and the bed, and removed the noise at a specific area through a masking process (Fig. 4). Prior to the tests, the body pressure mattress was calibrated the sensors. 3 Korean males in their twenties were selected as subjects (average age: 27 years, average height: 173cm, average weight: 81kg). This study measured the change in the contact force and the contact pressure between the subject and the bed during the time from the lowest height to the highest, and performed lifting tests 8 times for each speed pattern of the subjects, and compared the average value of 6 times excluding the maximum and minimum values.

3. Study Results and Discussion

This study measured the contact force of the subjects for each speed pattern of the lifting tests, and selected the head and hip to examine the change in characteristics of the contact force at local parts of the body. The contact force and the maximum contact pressure were greater in case of 17 seconds compared to 30 seconds. For the contact force, this study found the change in contact force near the start and/or stop zones for Types A and B. However, there was no significant change for Types C, D and E (Fig. 5). The greatest difference between the maximum and minimum contact force was obtained from type D (Max. : 521.2N, Min. : 472.8N) (Fig. 6).

For the head, the maximum contact force was the highest at Type E (17.6kPa) in case of 17 seconds, and lowest at Type B (14.4kPa) in case of 30 seconds. For the hip, the maximum contact force was the lowest at Type D (19.8kPa) in case of 17 seconds, and lowest at Type C (15.8kPa) in case of 30 seconds (Fig. 7). It is thought that, as the lifting time was reduced, the acceleration increased, and thus the contact force and the maximum contact pressure increased. It is desirable to design the speed patterns so that the change in acceleration during the lifting can be minimized, and required to select the optimal speed pattern by sensibility evaluation tests for users.

4. Conclusions

This study performed a lifting test by setting five types of speed patterns (maximum stroke and lifting time) to obtain the design parameters necessary to develop a lifting module installed in senior-friendly products for indoor movement. By measuring the contact force and the maximum contact pressure through the subjects, this study could quantitatively obtain the lifting speed pattern with less rapid change. It is expected that an optimal lifting module can be developed to provide convenience to the users by performing lifting tests with the elderly as subjects based on the results of this study.

5. Acknowledgement

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Fig. 4 Body Pressure Distribution and Noise Area

Fig. 5 Contact Forces between Subject and Bed

Fig. 6 Comparison of Maximum Contact Force

Fig. 7 Comparison of Peak Pressure in Head and Hip Areas