COMPARISON AND ANALYSIS OF STS(SIT-TO-STAND) MOTION BETWEEN THE OLD AND THE YOUNG FOR DESIGN A STANDING ASSISTANT CHAIR EQUIPPED WITH A SEAT TILTING FEATURE

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INTRODUCTION

Fall–related injuries are the leading cause of indoor accidents among the elderly. The case in point may be the front door of a house and a bathroom where older adults frequently stand up and down. To prevent fall accidents from happening, various standing assistant chairs have been developing, but a standing assistant chair equipped with seat tilting feature is a few and not powerful due to its gas cylinder structure.

Furthermore, the previous studies have found that STS(sit-to-stand) research regarding degrees was not sufficient and experimental research based on the elderly has not been conducted. This study is aimed at comparing and analyzing STS motion between the older and the young in order to lay a foundation for designing a senior-friendly standing assistant chair equipped with a seat tilting feature.

METHOD

The subjects of study were consisted of 7 younger women(age: 21.9±1.4, Height: 159.5±3.4cm, Mass: 50.2±2.8kg) and 7 older women(age: 64.4±3.2, Height: 153.9±4.4cm, Mass: 60.5±5.9kg).

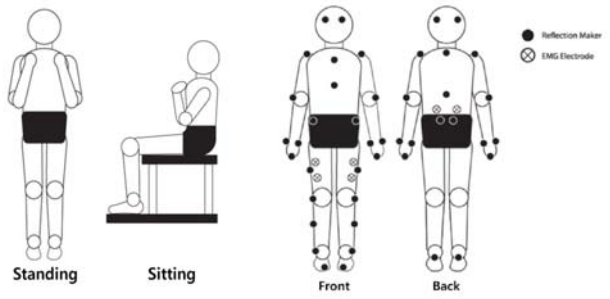

Figure 1: The posture of motion capture, The position of reflection makers and EMG electrodes.

In case of STS experiment, a subject's posture was poised for the same (2009, Kathleen A Bieryla) and procedure and motion's speed tried to remain equal(2008, Yasin B. Seven). The previous studies about STS motion was a basis for variables(Muscle activation, Joint moment).

10 cameras(MX-T20, VICON INC. UK.) and 2 Force plates(OR6_7-2000, AMTI INC. USA.) were used for capturing a three-dimensional motion against tilting degrees(-5˚~35˚) for supporting standing, Plug in gait full body marker set was used to conduct the experiment. When it comes to analyzing motion, both knee joint moment and hip joint moment (1990, Winter, D.A) were used to parameter of results.

The muscle activity of each tilting angle was measured using six channels of wireless EMG system(Trigo Delsys INC. USA.). Erector spinae (Bazrgari B), Rectus femoris and Vastus lateralis were measured. Muscle activity was analyzed through a normalization process with MVC(maximum voluntary contraction).

RESULTS

Results of Joint moment (Figure 2)

The results from knee and hip joint moment for older group and young group against degree of seat tiling were different from the two groups. Both of them had a tendency to lower the results from hip moment. Among the older group, 610Nmm resulted in 10˚ that was the highest and 35° showed at its lowest level 494Nmm. Among the young group, 5˚ led to 870Nmm that was the highest and 35˚ showed at its lowest level 734Nmm. When it comes to Knee joint, a result from older group, actually, tended to increase by higher degree: 5˚ showed at its lowest level

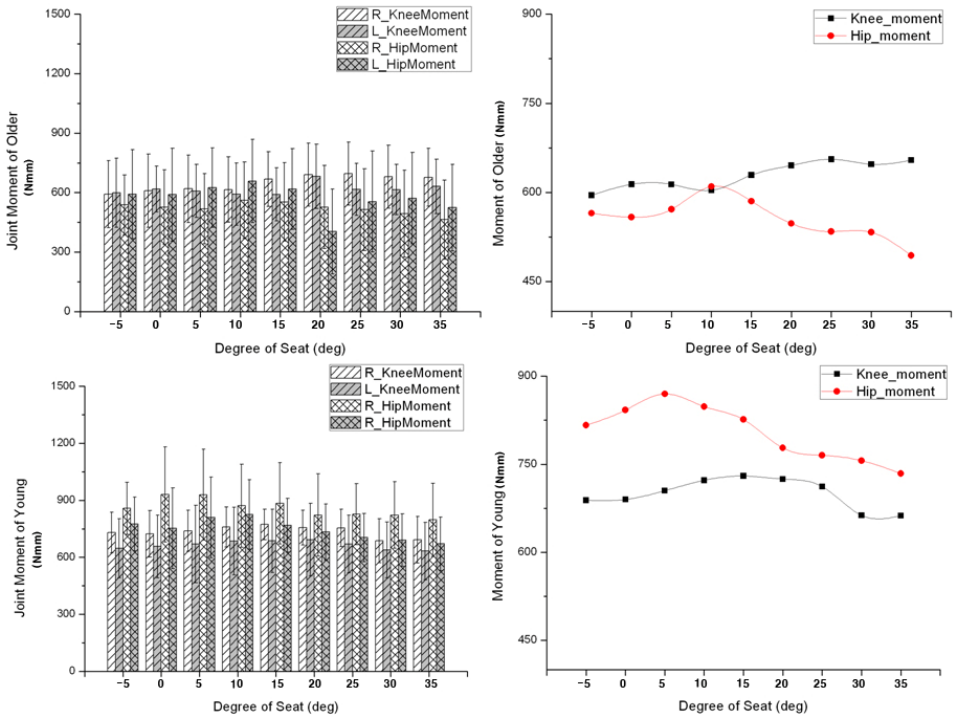

Figure 2: Knee and hip joint moment of older and young

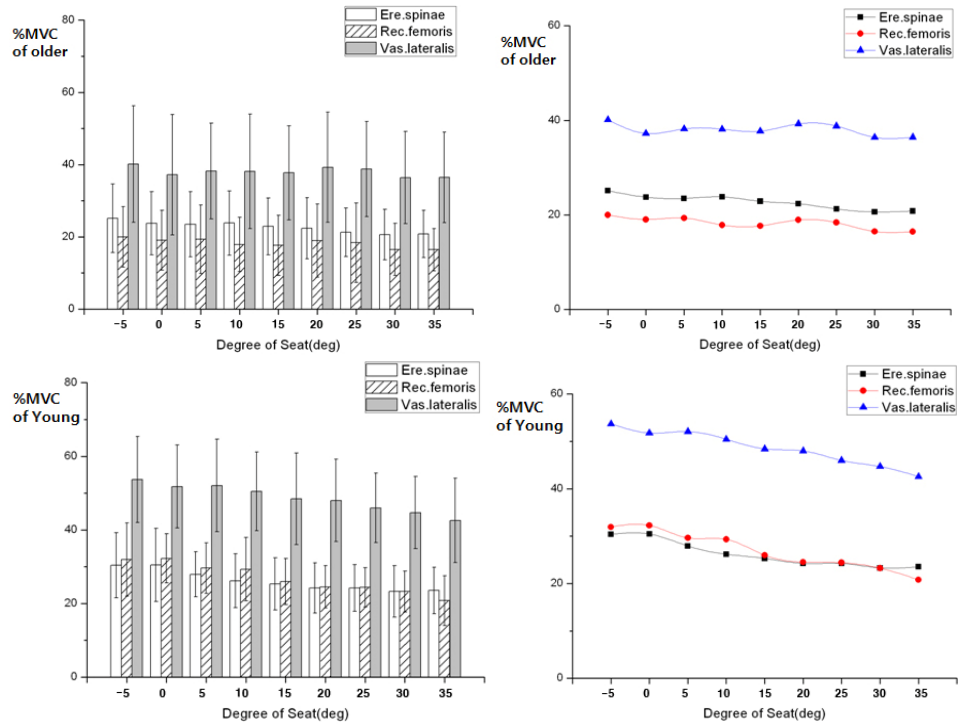

Figure3: Muscle activity of older and young

595Nmm, ranging from 0deg to 5˚ increased a little bit to 613Nmm, 10˚ led to 604Nmm, with gradual increase, 25˚ was at the highest level 656Nmm and stayed moderately to 35˚. In case of young group, a starting point was -5˚ and 689Nmm, ranging from 5˚ to 15˚ showed at the highest level 730Nmm, while 35˚ became at its lowest level 662Nmm, a higher degree tended to decrease after 15˚.

Results of EMG(%MVC) (Figure 3)

The results of EMG based on the degrees from seat tilting are normalized by the %MVC. It found that muscle activity of older group and young group has reduced. While the young group has higher results and tends to decrease significantly among all muscles, the results of the older group have a tendency to reduce with lower tilt.

The results from the older group indicated, firstly, Erector spinae starts at 25.1%(-5˚) with 30˚ at its lowest level 20.6%, tends to reduce with moderate tilt. Secondly, Rectus femoris indicates 20˚ hits the highest at 19% and 30˚ is the lowest at 16.5%.

Thirdly, Vastus lateralis shows at the highest level relatively. -5˚ is the highest at 40.1% and 30˚ is the lowest at 36.4% with repeated increase and decrease.

The results from the older group indicated, firstly, Erector spinae starts at 30.4%(-5˚) with 30˚ at its lowest level 23.3%, tends to reduce with moderate tilt ranging from 5˚ to 35˚. Secondly, Rectus femoris indicates 0˚ hits the highest at 32.2% and 35˚ is the lowest at 20.8%. Thirdly, Vastus lateralis shows at the highest level relatively like the older group. -5˚ is the highest at 53.7% and 35˚ is the lowest at 42.6%.

DISCUSSION

The increased tilt degree inclines to decrease the results of joint moment and muscle activity, but there are differences between the two groups. The older group has a lower level than the young group in term of the results of joint moment and muscle activity, the variation rate is too small. In analysis of knee joint moment, the results of joint moment from the older group show that knee joint moment and hip joint moment are the opposite. When it comes to developing a senior- friendly standing assistant chair, to come up with an optimizing degree may be a hard experimental result. It may be recommendable to develop the chair equipped with adjustable degrees rather than the best degree(only one).

When developing a standing assistant chair that reflects the results, Adjustable tilting degree needs to be designed so that users can stand at comfortable height.

Muscle activity from the older group shows that a relatively equable curve is found from 10˚ to 30˚. The graph from joint moment for older group indicates that curves from two graphs(knee, hip) start to split. Considering the two results, it may be desirable to design an adjustable range of tilting degree from 10˚ to 30˚.

In order to analyze the cause of difference derived by the joint moment between the two groups by using motion capture result, the two group's difference will be analyzed regarding change of arthromeric angle, movement, posture and velocity of angles under STS.

CONCULSION

This study was aimed at finding the best tilting degree in the process of developing a senior-friendly assistant standing chair equipped with seat tilting feature. As a result, the adjustable chair is better for seniors than the chair with one tilting degree. The results of knee join moment and EMG suggest the angle (10˚~30˚)-adjustable seat can be desirable. When it comes to developing the senior-oriented chair, the results of this study are expected to design and make a standing assistant seat.

The results from the two groups show that there are many differences of muscle power, joint-moment and motion pattern between them under the equal movement and terms. The development of senior-friendly product should assess the differences between older group and general group in order to design the most appropriate product for this group. To deal with these problems, a usability test and an evaluation are considered to be very important for the elderly.

ACKNOWLEDGEMENTS

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