THE EFFECT OF FOOT PLACEMENT ON SIT-TO-STAND WITH AND WITHOUT WALKER ASSISTANCE

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INTRODUCTION

Moving from a sitting to standing position is a transfer that is essential to perform activities of daily living. Individuals having dysfunctional or weak lower extremities may have difficulty performing sit-to-stand movements and may depend on others for assistance. For example, frail elderly and those who have suffered a spinal cord injury may struggle with sit-to-stand movements. If leg strength is insufficient, the upper extremities play an important role in the standing up process. Greater arm assistance reduces maximum hip and knee joint torques by up to 50% [1]. Janssen et al. concluded that repositioning of feet influenced the strategy of the sit-to-stand movement and required lower extension moments at the hip [2]. The present study is aimed at finding how foot placement with or without walker assistance alters the biomechanics of sit to stand in healthy adults.

METHODS

Four subjects (2 male/2 female, age 25 ± 5 yr, height 173 ± 20 cm) participated in this experiment. The subjects did not have any musculoskeletal disorder that would hinder their sit-to-stand performance. An eight-camera video System (Peak Performance, Englewood, CO) was used to track ten reflective markers placed on both sides of the subject's body. The subjects sat on a bench (height 45 cm) with their feet on two separate force platforms (AMTI, Watertown, MA). A Guardian Easy Care adult folding walker was used as an assist device for sit-to-stand. Two triaxial force sensors (Kistler, Amherst, NY) were used for measuring the hand forces applied on the walker.

The subjects sat with their feet shoulder width apart. The protocol involved two independent variables. The first independent variable compared standing with and without the assistance of a walker. The second independent variable that was tested involved three different initial postures: the feet anterior with respect to the knees (foot-forward) at an angle of 80° of knee flexion, the feet even with the knees (foot-even) at an angle of 90° of knee flexion, and the feet posterior with respect to the knees (foot-back) at an angle of 100° degrees of knee flexion. Hand support forces and joint moments were calculated during sit-to-stand movements for these six conditions. Each subject performed three repetitions of the six sit-to-stand conditions for a total of 18 trials.

RESULTS AND DISCUSSION

Maximum hip extension moments increased from foot-back to foot-forward (Fig.1). The hip extension moments without walker assistance were higher than when using a walker for all foot positions. Maximum knee extension moments without walker assistance decreased from foot-back to foot-forward. Knee extension moments with the walker did not show as much of a change with foot positioning. Knee extension moments for foot-forward were higher with walker assistance than without. Maximum ankle plantar flexion moments for foot-back (46Nm) were greater than foot-forward (23Nm) with the walker. The hand forces also showed a consistent trend. The vertical, anterior, and lateral forces increased gradually from foot-back to foot-forward. The average vertical forces were 18% body weight for foot-forward and 11% body weight for foot-back.

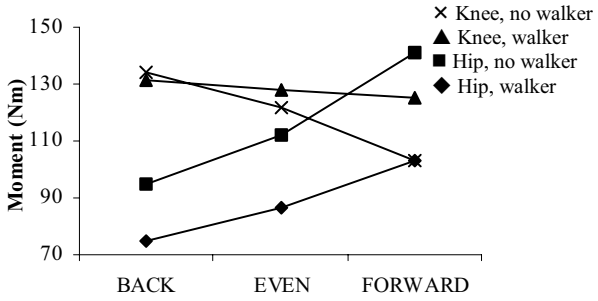

Figure 1: Hip and knee joint moments for alternative foot placements with and without walker assistance.

The results suggest that if a person has weakness in the hip, a foot-back placement will help reduce the moment requirements on the hip. Walker support in combination with a foot-back placement will facilitate lowering the hip moment requirements even further. This combination will also reduce the hand forces required on the walker, which is important because elderly individuals may have low upper body strength. The knee moments were substantially lower without walker assistance for the foot-forward placement. This may be due to the restricted range of motion of the upper body that reduces the amount of momentum generated. However, there was little difference between knee joint requirements with or without walker assistance when using the foot-back placement.

In addition, the results suggest that the net moment requirements of the body are reduced at the foot-even placement if standing with the help of a walker and the foot-back position if standing without any external support. These results can be used to help optimize stimulation patterns for paraplegics using functional neuromuscular stimulation systems to perform sit-to-stand. They can also be used to choose an appropriate foot placement to help reduce the force requirements for people with weakness in specific joints.

REFERENCES

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2. Janssen WGM, et al. *Phys Ther* **82**, 866-870, 2002.

ACKNOWLEDGEMENTS

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