LOAD DISTRIBUTION DURING SIT-STAND-SIT USING AN INSTRUMENTED CHAIR

Susan K. M. Wilson, Alexander C. Nicol
Bioengineering Unit, University of Strathclyde
Email: s.k.m.wilson@strath.ac.uk , web: www.strath.ac.uk

INTRODUCTION

Older adults have more difficulty in rising from a chair due to physical changes that occur due to ageing, as well as the design of chairs [1]. Ageing causes a decline in muscle strength and a reduction in control noted particularly as the elderly are more prone to falls. There are many aspects of chair design that can influence the ability of the elderly to rise including chair height, type of seating surface, cushions, foot placement, and armrests [2].

METHODS

A portable instrumented chair was designed to measure the forces through the body during standing up and sitting down by means of force plates and transducers. Two Kistler force plates (FPs) are located in the floor for measuring individual foot forces, and a third force plate is located beneath a cushion on the seat. The armrests were instrumented with pylon transducers to measure 3 dimensional forces through the upper limbs. The equipment is integrated with a Vicon 612 motion analysis system (©Oxford Metrics) to enable synchronization of data. The chair can be adjusted in height by means of a hydraulic jack and support rods which are locked in place, and the height of the armrests can also be adjusted (figure 1).

The chair was adjusted to 87.5% of knee height and each subject was asked to stand up and sit down from the chair at their own pace. Two floor mounted force plates were used during testing and the results summed for the graph in figure 2. Each subject was asked to rise without using the armrests. Two different types of seat cushions were used during testing: a polyurethane foam with a vinyl cover (soft cushion) and a high density foam with a cotton cover (hard cushion). Data was recorded in 6 degrees of freedom for both the floor and seat force plates.

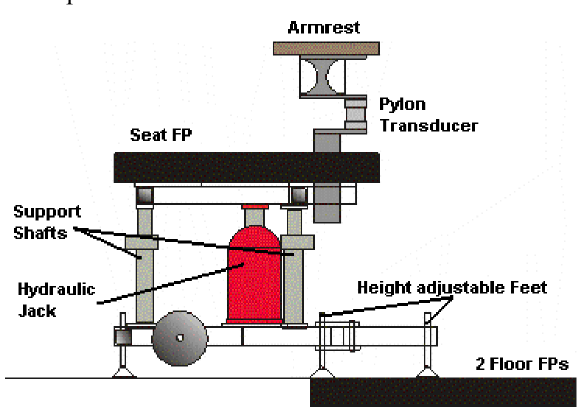

Figure 1: Diagram of components of the instrumented chair.
FP: Force Plate.

RESULTS AND DISCUSSION

Figure 2 illustrates the vertical forces that arose from the seat and floor force plates during testing. At the start of testing the subjects body weight was distributed 80% through the ischial tuberosities to the seat and 20% through both feet to the floor. It can be seen that zero force at the seat FP indicates lift-off from the seat which occurs momentarily before peak vertical foot floor force.

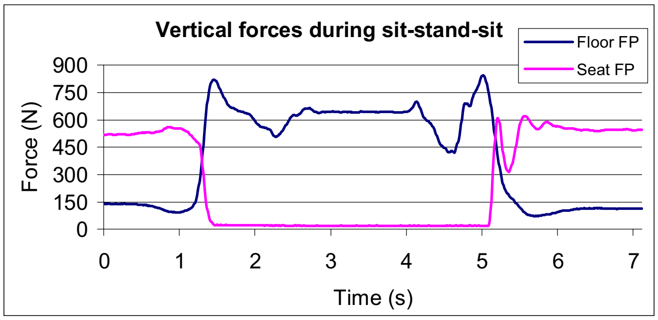

Figure 2: Vertical ground reaction forces at the seat and floor force plates during rising to stand and sitting down.

Figure 3 displays a peak horizontal force measured at the seat of 100N when rising to stand which occurred at the same instant when the vertical forces at both the seat and floor FPs were of equal magnitude (figure 2).

This variation in reaction forces may have been due to the seat height being lower than knee height, requiring more momentum to be generated in the forward direction to assist rising and control in sitting. These results indicate that sit-stand-sit is a complex movement that occurs in more than one plane and requires further detailed analysis in 3dimensions.

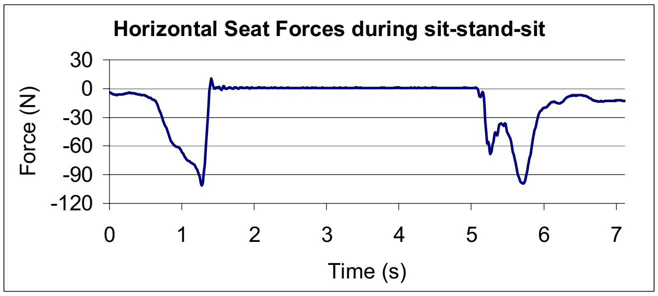

Figure 3: Horizontal forces measured at the seat and floor force plates during rising to stand and sitting down.

REFERENCES

1. Alexander NB, et al. *J Am Geriatr Soc*, **44**, 356-362, 1996.
2. Janssen WMG, et al. *Physical Therapy,* **82(9)**, 866-879, 2002.