KINEMATICS OF LATERAL TRANSFERS: A PILOT STUDY

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INTRODUCTION

People with spinal cord injuries (SCI) must transfer many times daily. Despite the importance of proper transfers, researchers have not completely described the kinematics of lateral transfers. Nyland *et al* identified transfer technique as a risk-factor for upper extremity degeneration and cited the need for quantitative measures of transfers and additional transfer research [1]. The purpose of this pilot study was to collect kinematic data on lateral transfers and identify different transfer strategies.

METHODS

A convenience sample of 19 male adults was recruited from Shepherd Center (an acute SCI rehabilitation center) with IRB approval. Subjects had to be able to perform lateral transfers independently or with minimal assistance and could not have pressure sores or upper extremity orthopaedic conditions. Data was collected with a motion capture system from Motion Reality Inc. (Marietta, GA). We used eight 60Hz cameras and 41 markers on the body and 8 on the wheelchair. After providing written consent, subjects performed three lateral transfers to their stronger side between their own wheelchairs and a 20" high therapy mat. They were provided as much assistance as they generally used.

For each subject, two average values (transfer to the mat and transfer to the chair) were calculated for the following descriptors of transfers: **maximum buttock height, minimum head height, wrist spacing and torso angle**. Wrist spacing (the distance between the left and right wrist body segments) and torso angle (the angle between the projections of lines running through the shoulders and through the hips) were measured at the mid-transfer point. Time zero was set at the **mid-transfer point,** which was defined as the point where the buttocks reached a maximum height between the final lift-off from the chair (or mat) and the initial contact with the mat (or chair). Paired t-tests were used to compare maximum buttock height, minimum head height, wrist spacing and torso angle during transfers to and from the wheelchair.

RESULTS AND DISCUSSION

Subjects elevated their buttocks an average of 11 inches above the therapy mat at mid-transfer (Table 1). They lowered their heads to approximately 21 inches above the mat. Subjects did not display a significant difference in buttock and head heights when transferring to the mat versus transferring to the wheelchair. On average mid-transfer (or maximum buttocks height) and minimum head height were separated by 0.3±0.5 seconds for transfers to the mat and 0.1±0.6 seconds for transfers to the wheelchair.

Subjects' wrists were spaced similarly at mid-transfer in transfers from the wheelchair (25.5") and transfers to the wheelchair (26.2"). The amount of torso rotation varied greatly between the subjects. The average angles formed by the shoulders and hips were nearly identical in transfers to and from the wheelchair (24° & 23°).

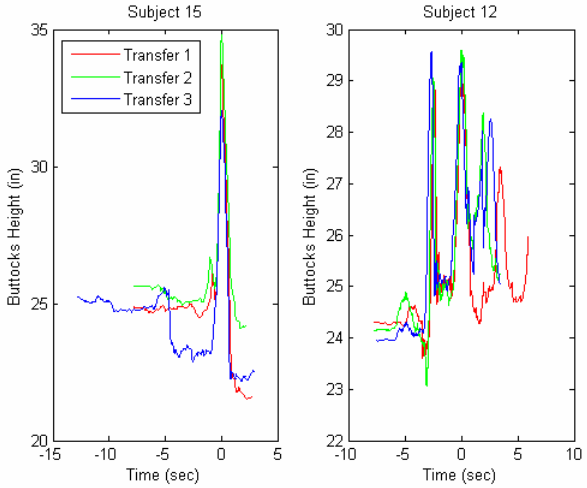

Figure 1: Two subjects' transfers to the mat are shown. Transfers to the wheelchair looked similar. Subject 15 (C6/7, Asia A) performed a smooth transfer with only one peak of buttock elevation while Subject 12 (T8, Asia C) used more buttock elevations to complete the transfer task.

A variety of transfer strategies were used by our subjects to complete the transfer task (Figure 1). The variation in buttock height within each subject's transfers was greater for transfers to the wheelchair than transfers to the mat (p=0.0335).

CONCLUSIONS

People with SCI use a variety of strategies to transfer between two surfaces. The different transfer strategies might be correlated to such factors as injury level, time since injury or body weight. Future work will cluster the transfer strategies in order to determine these relationships. Additionally, it is possible that the repeatability of the transfers might be related to upper extremity pain or safety of transfers. Further work with a greater number of subjects is needed to determine these relationships.

REFERENCES

1. Nyland J, et al. *Spinal Cord* 38: 649-657, 2000.

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	Transfer to Mat		Transfer to Wheelchair	
	Mean ± Stdev	**Range**	**Mean ± Stdev**	**Range**
Max Buttock Height	11.6" ± 1.6"	8.4"-14.8"	11.4"±2.0"	7.7"-17.3"
Min Head Height	21.2"±3.4"	13.9"-28.0"	21.8"±2.7"	35.1"-47.5"
Wrist Spacing at Mid-Transfer	25.5"±3.9"	18.3"±35.5"	26.2"±4.1"	19.0"±36.9"
Shoulder-Hip Twist Angle	23° ± 8°	6° - 38°	24° ± 8°	8° - 47°

Table 1: Summary of transfer measurements shows minimal variation in maximum buttock height and much greater variation in torso rotation. No significant differences were seen between transfers to the mat and the wheelchair.