SAFE PATIENT HANDLING: A KINEMATIC ANALYSIS OF DEVICE-ASSISTED VERSUS NO DEVICE SIT-TO-STAND MOTION

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INTRODUCTION

Workplace injuries in the rehabilitation environment are of significant concern due to their impact on patient care. One common activity that leads to injuries is transferring from one surface to another (e.g., bed to chair) [1]. Mechanical devices have been developed to assist with transfers and to reduce the risk of injury. To date, no research has systematically compared the extent to which patient movements within these devices simulate normal transfer motions. Knowledge of the biofidelity of these movement patterns could help guide clinical use of select devices within therapeutic treatment programs aimed at enhancing patients' independent transfer skills. The purpose of this study was to compare sagittal plane trunk, pelvis and lower extremity kinematics recorded during sit-to-stand movements with and without a transfer device.

METHODS

Ten young, healthy adults participated (5 males, 5 females). Sagittal plane kinematics were recorded using a 12-camera motion analysis system (Qualisys Motion Analysis System, Gothenburg, Sweden) to determine trunk, pelvis and thigh positions relative to vertical and knee and ankle joint angles. A Vancare VeraLift power-assisted sit-to-stand device was used for the device-assisted trials. Each participant performed three sit-to-stand trials with no device (ND) and six device-assisted sit-to-stand trials: three giving their best effort to assist the device (DA-BE) and three offering no effort to assist the device (DA-NE). Separate, one-way analyses of variance (3x1 ANOVA) identified key differences in INITIAL (0% movement cycle; seated) and FINAL (100% movement cycle; standing) positions between ND, DA-BE and DA-NE. The coefficient of multiple correlations (CMC) [2] quantified similarities in kinematic profiles between ND and DA-BE and ND and DA-NE.

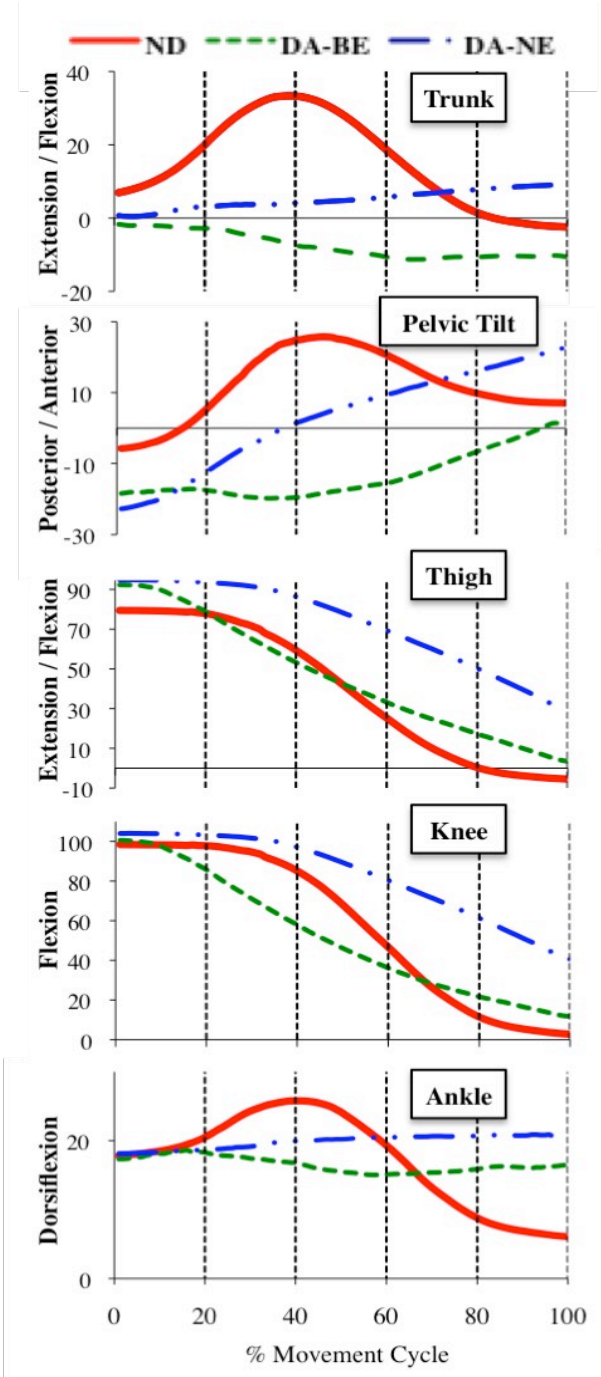

Figure 1: Mean sagittal plane joint angles recorded during sit-to-stand motion.

RESULTS AND DISCUSSION

The mean ensemble plots arising from performance of the three conditions are provided in Figure 1. Table 1 identifies significant differences in INITIAL and FINAL positions across conditions. CMC values comparing movement profiles across the three conditions are presented in Table 2.

Table 1: Comparison of initial and final joint postures during the three transfer conditions.

Region	Phase	Significant Main Effect ($P < 0.00625$)
Trunk	INITIAL	ND>DA-BE
	FINAL	DA-NE>ND>DA-BE
Pelvis	INITIAL	ND>DA-BE, DA-NE
	FINAL	DA-NE>ND, DA-BE
Thigh	INITIAL	DA-BE, DA-NE>ND
	FINAL	DA-NE>DA-BE, ND
Knee	INITIAL	NS (p=0.139)
	FINAL	DA-NE>DA-BE, ND
Ankle	INITIAL	NS (p=0.916)
	FINAL	DA-NE, DA-BE>ND

The trunk began and ended in significantly more flexion in the ND condition compared to DA-BE. DA-NE had greater trunk flexion than ND only at the end. The pelvis began in significantly more posterior tilt in DA-BE and DA-NE compared to ND. Final pelvis position was significantly more anteriorly tilted during DA-NE compared to other conditions. The thigh started in greater flexion in DA-BE and DA-NE compared to ND. The end thigh position was more flexed in DA-NE compared to other conditions. While the starting knee posture did not differ across conditions, DA-NE demonstrated significantly greater flexion at cessation compared to DA-BE and ND. The overall arc of ankle movement was limited in device-assisted movement. Initial ankle postures were similar across conditions; however, ND posture was significantly less dorsiflexed at cessation compared to device-assisted movement.

CONCLUSIONS

A key goal for many rehabilitation patients is to learn to independently transfer between positions. When profound weakness and balance prevent the patient from safely performing this task, external human and/or device assistance is often required. Device-assisted movement patterns that simulate normal transfers could enable clients to transfer safely and to practice the activity they seek to relearn. The current study focused on the movement patterns occurring in one sit-to-stand transfer device frequently used in rehabilitation settings. DA-BE movement patterns in the VeraLift most closely emulated normal sit-to-stand movements at the thigh and knee as evidenced by the high CMC values. CMC values for these same anatomic regions dropped notably during the no effort condition. The lowest CMC values between the device-assisted conditions and normal sit-to-stand movements occurred at the trunk, pelvis and ankle.

The current study represents a first step in exploring the biofidelity of device-assisted sit-to-stand movement patterns. Further research is required to explore movement patterns (joint motions and muscle activation patterns) in other devices frequently used in rehabilitation settings; as well as to identify the impact patient pathology has on the clinician's ability to facilitate optimal movement and muscle activation patterns.

REFERENCES

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Table 2: Coefficients of multiple correlation (CMC) values comparing kinematic profiles during each device-assisted condition to the no device condition at the trunk, pelvis, thigh, knee and ankle.

	Trunk	Pelvis	Thigh	Knee	Ankle
Device-assisted: best effort	0.49 ± 0.11	0.35 ± 0.11	0.97± 0.02	0.95 ± 0.03	0.69 ± 0.11
Device-assisted: no effort	0.56 ± 0.09	0.75 ± 0.12	0.83 ± 0.04	0.86 ± 0.07	0.58 ± 0.10