Turning of Individuals with Unilateral Lower-Limb Loss: Preference and Biomechanics

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INTRODUCTION

Turning is necessary to accomplish activities of daily living and occurs at a rate of 70 turns per hour (Mancini, 2015). Turning is challenging for individuals with unilateral lower-limb loss, and those with a history of falls have reduced turn ability (Akins, 2017). Turning can be assessed using the Instrumented Stand and Walk (ISAW) test and has been used to investigate the effects of aging and Parkinson's disease on balance and gait. The objectives of this study were to: (1) investigate turn direction preference and (2) quantify turn characteristics in each direction.

METHOD

Subjects: Individuals with unilateral lower-limb loss (n=21, two female, 44.1±15.4 years, 178.6±6.8 cm, 91.9±14.8 kg) and able-bodied controls (n=23, seven female, 32.9±12.7 years, 176.2±9.9 cm, 79.5±16.9 kg) were enrolled in this IRB-approved study.

Apparatus: Patient-reported questionnaires were the Prosthetic Limb Users Survey of Mobility (PLUS-M) (Hafner, 2016) and Activities-Specific Balance Confidence (ABC) Scale (Powell, 1995). The Mobility Lab (APDM, Inc., Portland, OR) was used and consists of six wireless inertial sensors secured to the feet, wrists, lumbar spine, and sternum.

Procedures: Participants completed questionnaires and two ISAW trials. ISAW combines measures of postural sway, anticipatory postural adjustments during step initiation, gait, and turning. Participants stand naturally for 30 seconds, walk forward 7 m, turn 180°, and walk back 7 m. No instructions on turn direction were provided. Participants performed the second ISAW trial turning in the opposite direction.

Data Analysis: Turn direction preference was defined as the turn direction performed on the first trial. Separate Fisher's Exact tests were conducted to assess associations between turn direction preference and amputation status (limb-loss/control), limb dominance (dominant/non-dominant), amputation side (sound/prosthesis), and amputation level (transtibial/transfemoral) (α=0.05).

Turn characteristics were defined as turn angle, duration, angular velocity, and number of steps. Pairwise comparisons were used to determine differences in turn characteristics between turning toward the prosthesis and sound limb, and between turning toward the dominant and non-dominant limbs.

RESULTS

The mean (SD) perceived mobility percentile was 89.4 (11.4) percent. Balance confidence scores were 96.2 (4.9) percent for individuals with lower-limb loss and 97.2 (5.0) percent for controls. No associations were identified between turn direction preference and other variables. Turn characteristics for controls did not differ based on limb dominance. Individuals with lower-limb loss performed turns toward the sound limb with greater angular velocity compared to the prosthesis (Table 1).

Table 1. Turn characteristics of individuals with lower-limb loss (n=21). Data are mean (SD).

	TOWARD PROSTHESIS	TOWARD SOUND	P-VALUE
Angle (°)[a]	178.5 (14.1)	184.7 (6.1)	.093
Duration (s)[b]	2.2 (0.6)	2.2 (0.5)	.636
Velocity (°/s)[b]	193.8 (35.4)	212.5 (50.9)	.041
Steps (#)b	3.7 (1.2)	3.7 (0.9)	.886

[a]Related-samples Wilcoxon signed rank test.
[b]Paired t-test.

DISCUSSION

Individuals with lower-limb loss were expected to preferentially select turning toward the sound limb, but no significant associations were identified. This finding may be due to the high perceived mobility and balance confidence of the cohort. Individuals with lower-limb loss performed turns toward the sound side with greater angular velocity compared to turns toward the prosthesis. The reduced angular velocity may be due to a lack of musculature and altered afferent signals, but it does not appear to be due to balance confidence given the high scores. The convenience sample limits the generalizability of results to the lower limb-loss population. We plan to assess individuals with lower-limb loss who are more representative of the population in future studies.

CONCLUSION

Individuals with lower-limb loss had no preference for turn direction when performing a 180° turn and turned with greater angular velocity toward the sound limb.

CLINICAL APPLICATIONS

Turns occur often, and differences in turn characteristics exist in individuals with lower-limb loss. Turning tasks should be a focus of rehabilitation.

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