Exploring the Associations between the Biomechanical and Psychological Mechanistic Pathways of Lower Back Pain Development amongst Persons with Lower-Limb Amputation

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Summary

Biomechanical and psychological pathways contributing to lower back pain (LBP) were examined in adults with lower-limb amputation (LLA) during gait and sit-to-stands (STS) over 6-months. Significant improvements in gait velocity and STS performance over time reflect the enhanced mobility and prosthetic limb adaptability. Trunk movements showed a negative correlation with LBP severity and Kinesiophobia at later stages, while pelvic parameters remained unchanged.

Introduction

Biopsychosocial factors (e.g., fear-avoidance behaviours) increase the risk of LBP in persons with LLA [1]. We hypothesise that trunk and pelvis kinematics may be associated with psychosocial factors, such as fear-avoidance behaviours. Therefore, this study aims to understand the relationships between LBP, pelvis and trunk biomechanics, and psycho-social variables in adults with LLA over time.

Methods

The gait and STS movements of 20 unilateral amputees (60±15 years old) was assessed ~3-months post-amputation (time 0), and then every 3-months over a period of 12-months (time 1, 2, 3, and 4). Gait and STS kinematic and kinetic measurements were captured with eight cameras (Qualisys, Sweden) and one portable force plate (Kistler, Switzerland). A 3D full-body musculoskeletal model was created using Opensim 4.5 to simulate movement during twelve walking and six STS trials for each participant. At this stage, results are reported here for twelve participants (n= 9 transtibial; n = 3 transfemoral) at time 0, 1, and 2.

Results and Discussion

Mean gait velocity significantly increased overtime, indicating a progressive enhancement in gait performance, while LBP severity increased significantly between time 0 and time 1 (Table 1). There were no significant differences observed in the average pelvis and trunk angles across the time points during the gait cycle.

The time required to complete a full STS movement improved between time 0 and time 2 and between time 1 and time 2 ($p < 0.05$), indicating enhanced functional mobility over time. A negative correlation between LBP severity and average trunk flexion velocity at time 2 showed that individuals with greater LBP severity presented slower trunk flexion velocities (Figure 1). A negative correlation was also observed between Kinesiophobia and peak trunk flexion velocities at time 2, where individuals with greater Kinesiophobia scores showed slower trunk flexion velocities ($r = -0.59$, $p = 0.05$).

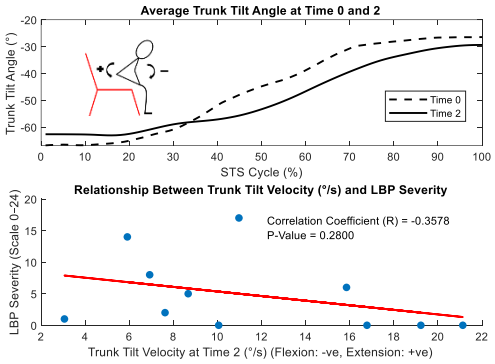

Figure 1: Trunk flexion range of motion and correlation between average trunk flexion velocity and LBP during STS trials.

Conclusions

The results demonstrate enhanced patients' functional mobility and adaptability. The trunk flexion velocity trend in severe LBP cases warrants further study, particularly regarding bar use for standing. Findings emphasise the need for long term research and a holistic rehabilitation approach integrating biomechanical and psycho-social factors to optimise LLA outcomes.

References

[1] Morgenroth, D. (2010). *Am J Phys Med Rehabil*, **89:** 635-643.

Table 1: Summary of the observed parameters over time (Average ± SD).* denotes a significant difference between time points ($p < 0.05$).

	Gait velocity (m/s)	Trunk flexion velocity (°/s)	Peak vGRF (N/BW)	Kinesiophobia	LBP
Time 0	0.52 ± 0.20	7.56 ± 4.57	10.66 ± 0.70	39 ± 9	3 ± 4
Time 1	0.63 ± 0.25*	8.78 ± 4.13	10.39 ± 0.40	37 ± 10	6 ± 5*
Time 2	0.65 ± 0.27	11.47 ± 5.90	10.46 ± 0.54	38 ± 10	5 ± 6