

INTRODUCTION

Motivation

- Slips, trips and falls injuries cause the US to sustain a damage of \$160 billion annually [1].
- Slipping is one of the main contributors to these injuries [2].
- Preventing severe slips (vs mild slips) would be of the key importance in fall prevention process.
- Previous studies have revealed a relation between an individual's gait control and slip severity [3].
- The Central Nervous System (CNS) might use a lower dimensional set of muscle synergies to control the gait [4].
- Hence, walking muscle synergies may potentially reveal an individual's risk of fall and slip severity.

Objectives

- To compare the walking muscle synergies between mild and severe slippers and find possible inter-group differences.

Hypotheses

- There are significant discrepancies in walking muscle synergies of mild and severe slippers.

METHODS

Subjects

- A total number of 20 subjects (9 female) with an average age of 23.6 yrs. (SD=2.52) participated in this study.

Procedures

- Subjects were asked to walk at their convenient speed on a walkway (while wearing reflective markers) in order to collect the walking data.
- After the walking trial, the floor was contaminated (without informing subjects) to generate an unexpected slip and the slipping data were collected. Subjects' safety was guaranteed by wearing an over-head harness.
- This IRB-approved study was completed in University of Pittsburgh. The unidentified data was transferred to Texas A&M University for analysis upon a secondary IRB approval.

| | W1 | W3 | W3 | C1 | C3 |
|------------|-------|-------|-------|---------|---------|
| Difference | VL_NS | MH_S | MH_S | 10%-18% | 37%-46% |
| P-value | 0.003 | 0.010 | .0009 | <0.05 | <0.05 |

Table. 1 Severity groups' discrepancies

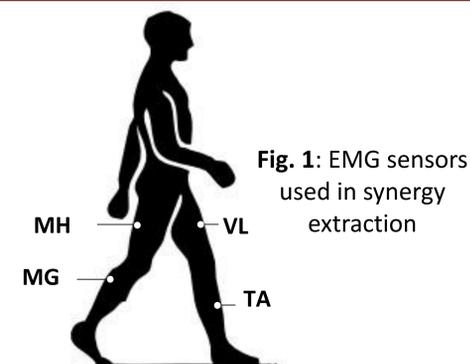


Fig. 1: EMG sensors used in synergy extraction

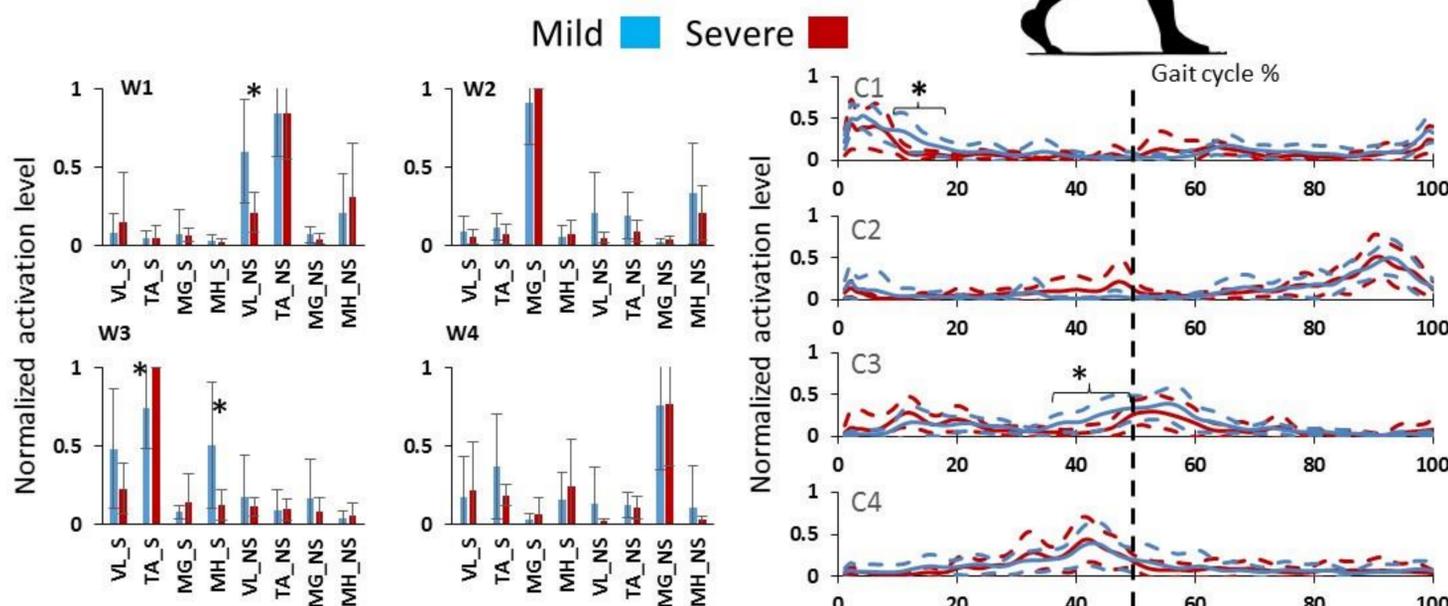


Fig. 2: Averaged synergies and activation patterns for each severity group. Error bars/dashed lines indicate SD. Asterisks indicate significant inter-group differences. Gait cycle starts from Right/NS heel strike with left/S heel strike at 50% (dashed line)

Data Collection

- EMG data were recorded bilaterally from 4 leg muscles: Tibialis Anterior (TA), Medial Gastrocnemius (MG), Vastus Lateralis (VL), and Medial Hamstring (MH) on left/slipping/leading leg (S) and right/non-slipping/trailing (NS) limb (Fig 1).

Analysis

- Markers data were used to identify the heel strikes to analyze one gait cycle.
- Markers data from slipping trial were used to categorize subjects to mild and severe slippers. A Peak Heel Velocity (PHV) greater than 1.44 m/s was labeled as a severe slip [5].
- The EMG data from one gait cycle were normalized to 100 data points (% of gait cycle) and used to extract synergies.
- The inter-group differences of the walking muscle synergies and activation coefficients were examined using independent *t*-tests ($\alpha=0.05$).

RESULTS

- 12 individuals were classified as mild slippers and 8 as severe slippers. 4 walking synergies were extracted (Fig 2)[6].
- Mild slippers activated their first synergy (from 10 to 18% of gait) and third synergy (from 37 to 46% of gait) more vigorously (Fig. 2, C1 and C3).

- More contribution of MH_S and VL_NS during gait was associated with mild slips, while higher activation of TA_S was observed in severe slippers ($p<0.05$) (Fig 2, W1 and W3, Table 1).

DISCUSSION AND CONCLUSION

- MH muscle decelerates the swing limb. A higher contribution of MH right before the heel strike (37-46% of gait) is associated with greater deceleration in the terminal swing and less slip severity.
- During the gait, mild slippers support their weight with more intensity as they activate VL (weight supporting muscle) more vigorously at early stance phase (10-18%).
- Excessive activation of TA right before the heel strike (C3, 37-46%) increases the foot-floor angle in the gait and is associated with severe slips [3].
- The application of this study is to use muscle synergies as a diagnosis and preventive measure for people with high risk of fall.
- Future studies would study the effectiveness of such a method in predicting slip severity in a larger number of participants.

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References

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