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.

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).
- 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 (α=0.05).

RESULTS

Data Table 1. Severity groups’ discrepancies

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