

## TOE-WALKING IN INTACT INDIVIDUALS ARISING FROM EMULATED CONTRACTURES OF SOLEUS, GASTROCNEMIUS AND HAMSTRING MUSCLES

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### INTRODUCTION

Toe-walking is very common gait irregularity in individuals with spastic plantarflexors and hamstrings. Identification of primary cause of toe-walking in particular patient is of utmost importance for deriving appropriate treatment. We therefore need an effective method for proper biomechanical characterization of particular gait irregularity.

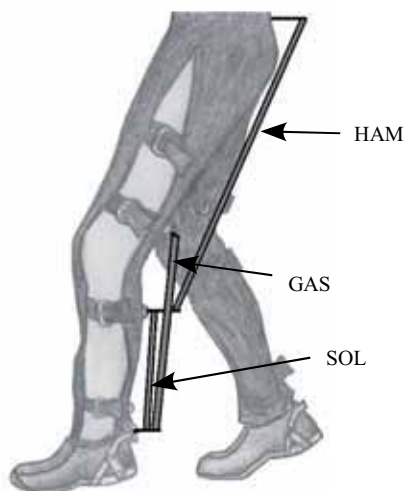
Recently two studies investigated compensatory gait deviations where toe walking was imposed in healthy adults by emulating a muscle contracture [1] or using special taping technique to form an equinus constraint [2]. Results lead to conclusion that different gait compensations should be expected when toe-walking is imposed by different constraints.

The purpose of this study is to emulate muscle contractures in individuals free from neuromuscular impairments as described in [1] and investigate which gait compensations arise when toe-walking is elicited by muscle contractures of soleus, gastrocnemius or hamstrings.

### METHODS

Figure 1 shows schematic drawing of the system that adds mechanical stiffness in parallel with particular muscle to emulate muscle contractures. Imitating primary gait irregularity by emulating contractures of soleus (SOL), gastrocnemius (GAS) or hamstring (HAM) muscles results in toe-walking but have characteristic compensatory gait deviations.

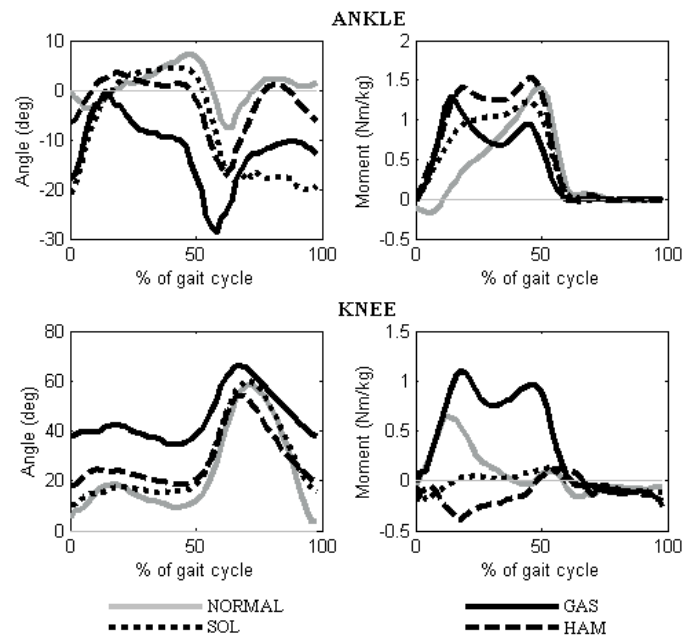
A volunteer equipped with the system walked along a 7 m walkway with walking speed approximately 1 m/s. We used VICON motion analysis system and two AMTI force plates for recording gait kinematics and kinetics of lower extremities.



**Figure 1:** Imposing various mechanical constraints to form muscle contracture emulations forcing the subject to toe-walk

### RESULTS AND DISCUSSION

Figure 2 presents ankle and knee angle and moment trajectories for different muscle contracture emulations imposed. All restrictive patterns are characterized with substantial plantar flexion and double-tooth moment trajectory which is consistent with results as recorded in Goodman et al. [1] and Matjačić et al. [2].



**Figure 2:** Ankle and knee angle and moment under different experimental conditions

Somewhat more distinctive are knee recordings when observing particular contracture emulation. Prolonged knee flexion and knee extensor moment throughout the stride as recorded in GAS muscle contracture emulations are consistent with results as reported by Matjačić et al. [1] and Goodman et al. [2]. On the other hand knee extensor moment was substantially diminished and excursions in knee angle were less evident when emulating SOL and HAM contractures.

### CONCLUSION

Results indicate that particular gait impairment will result in very distinctive secondary biomechanical effects and the proposed methodology for emulating muscle contractures may produce results that are potentially valuable for identifying compensatory gait deviations in clinical practice.

### REFERENCES

1. Matjačić Z, et al. *J Biomech*, in press, 2005
2. Goodman MJ, et al. *Gait Posture* **20**, 238-244, 2004