Gait Manipulation using Visual Feedback and its Influence on Ground Reaction Forces

-Nikita Grama BS
Brandon Wallace BA, Saluja Mahabamunage BA, Stanton Wilhite BS, Arwa Akram BS, Stephanie Wu DPM, MS

Mentor: Sai Yalla PhD
Disclosure

- Funding support – NIH partially supported by grant number 2T35DK074390 from the National Institute of Diabetes and Digestive and Kidney Disease

- The content is solely the responsibility of the authors and does not represent the official views of the National Institute of Diabetes and Digestive and Kidney Disease of the National Institutes of Health
Introduction

• Meta-analysis on 47 RCTs found increased physical activity in combination with modest weight loss reduces HbA1C levels in type 2 diabetics $^{1,2}$

Diabetes

- Normal to brisk walking$^5$
- Jogging 5mph or lower$^6$
- Non-weight bearing activities with weight loss

Risk Reduction

Improved Lifestyle

• Walking and jogging without proper guidance can pose an increased risk for ulceration/re-ulceration $^{3,4}$
Introduction

• Real-time visual feedback has been shown to reduce impact loading in knee osteoarthritis patients and recreational runners\(^7,8\)

• To validate a real-time visual feedback (VFB) program that assists manipulation of gait patterns to reduce ground reaction forces (GRF) during walking and jogging using wearable sensor technology.

• We hypothesized
  • Reducing tibial accelerations (Tacc) should reduce GRF in healthy participants while maintaining symmetry
  • Peak pressure during gait and jogging with VFB will reduce due to decreased GRF when compared to without VFB while maintaining VO2 consumption to a constant rate
Methods

• Inclusion criteria
  – Healthy with iPAQ score ≥ 600 Mets/min per week

• Exclusion criteria
  – Current foot injuries or pain
  – Systemic musculoskeletal conditions that affect day-to-day tasks
Methods

• 15 (9 male, 6 female) participants signed IRB approved consent

• Wearable sensors (Motion Workshop, WA, USA) were placed on the tibia of each leg to detect gait and jog parameters such as accelerations, velocity, swing, stance and symmetry
Motion node with tri-axial accelerometer, gyroscope and magnetometer
Equipment

- Labview based Visual Feedback program was placed using a TV screen in front of the participant.
- In-shoe pressure sensors (Pedar-X, Novel, Germany) were placed inside the standard shoes.
- All data collection was performed on a instrumented treadmill (Bertec corp) to measure GRF.
- A portable Oxycon metabolic system with a facemask was used to measure oxygen consumption.
Procedure

- Self-selected pace for both walking and jogging
- 5-10 minutes of acclimation time was provided
- After reaching steady state of VO2 consumption, baseline assessments were collected for 20 seconds
- A goal of reducing Tacc by 25% was set after baseline
- Only two basic recommendations were provided:
  - make footfalls quieter and
  - keep accelerations below peak line

- Once 25% reduction was achieved, data from all equipment in terms of in-shoe peak pressure, ground reaction forces, peak tibial accelerations and symmetry was recorded for 20 seconds.
Visual Feedback Program

Center for Lower Extremity Ambulatory Research @ RFUMS
Statistical Analysis

- To test differences between each condition during Feedback and no Feedback
  - Paired two sample t-test
  - Mann-Whitney U test was conducted when data set did not satisfy normality

- Alpha value 0.05, software – IBM SPSS 25
Results

• 15 (9 male, 6 female) participants ranging from 22 to 46 years

• Average demographics
  – Age 30.3 (±6.8) years
  – Height 69.3 (±4.3) inches
  – Weight 184.8 (±36.3) lbs
  – BMI 27.7 (±4.7)
Tibial accelerations

- **Tacc reduced by 36.8(±16)% (p<0.05) on average during walking**
- **Tacc reduced by 26.6(±13)% (p<0.05) on average during jogging**
Ground Reaction Forces

- Average peak GRF remained similar (no significant changes) during walking.
- During jogging, avg peak GRF reduced by 7(±15)% (p<0.05)
Peak pressure (PP) increased slightly 11.8(±15)% (p>0.05) while walking compared to baseline.

Forefoot PP remained similar (no significant changes)

- 10.1(±19.2)% during walking (p>0.05)
- 0.7(±1.6)% during jogging (p>0.05)
Discussion

• Symmetry was either maintained or improved while VO2 was not affected by visual feedback

• Average peak GRF was relatively low for walking and hence resulted in no major changes

• Peak Pressures at the forefoot remained close to 200KPa (safe range to avoid re-ulceration)

• Longer stride length worked best to reduce tibial accelerations
Limitations

- Sample size (15 subjects)
  - powered for safe use for diabetic subjects

- Visual lag during real-time
  - Ability to reduce Tacc was not affected

- Age and BMI
  - 53% of participants above 35 years
Conclusion

• Ground reaction forces can be reduced with Visual feedback especially during jogging

• Visual Feedback Program can be safely used in diabetic subjects to perform gait manipulation during walking and jogging
References


Thank You