Development of Mediolateral Ground Reaction Force across different Running Speeds to maintain a straight running path in Transfemoral Amputees

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Research Introduction

- Structural differences between affected and unaffected limbs of the lower extremity amputees caused a high level of mechanical asymmetry between them during locomotion [1]
- An appropriate M-L GRF profile that realizes a symmetrical mediolateral ground reaction impulse (M-L GRI) is essential for maintenance of straight running path [2]
- Research purposes: To examine the mediolateral ground reaction force (M-L GRF) profile in unilateral transfemoral amputees (TFA), and to identify their strategies in maintaining straight running

Research Protocol

- Nine participants were recruited
- Trials performed on instrumented treadmill (FTMH-1244WA; Tec Gihan, Kyoto, Japan)
- 6 x running trials (30 – 80% maximum speed)
- Maximum speed = average speed of fastest 100m recorded in competitions

Variables of interests

- M-L GRF (F_{avg})
- Mediolateral ground reaction impulse (M-L GRI)
- Step width (SW)
- Contact time(t_c)

Discussion

- M-L GRI was similar between limbs implied the ability to maintain a relatively straight running path were present among the participants
- Participants adopted similar strategies based on the similar SW observed.
  - Existing study shows lower SW as running speed increases in a single sprint among able-bodied runners [4]
  - Reduced range of motion of the lower extremities might have restricted TFAs ability to mediate SW [5]
- Significant main effect of limb were present on M-L GRF, (50% and 70% trials)
  - Suggests that limb-specific strategies were adopted to maintain symmetrical M-L GRI profile
- A more than proportionate decrease in t_c as running speed increases and a generally similar M-L GRF across all speeds resulted in a lower M-L GRI as running speed increased.
  - Lower M-L GRI implies that it might be easier to maintain straight running path at higher running speeds

References

1. Makimoto, A. (2017). J. Appl. Biomech,33(6), 406–409
2. Hisano, G. et al. (2021). J. Biomech., 115, 110201.
3. Sakata, H et al. (2020). Med Sci Sports Exerc, 52(4), 892–899.
4. Nagahara, R et al.(2017). Int. J. Sports Med, 38(7), 534–540.
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Data analysis and Result

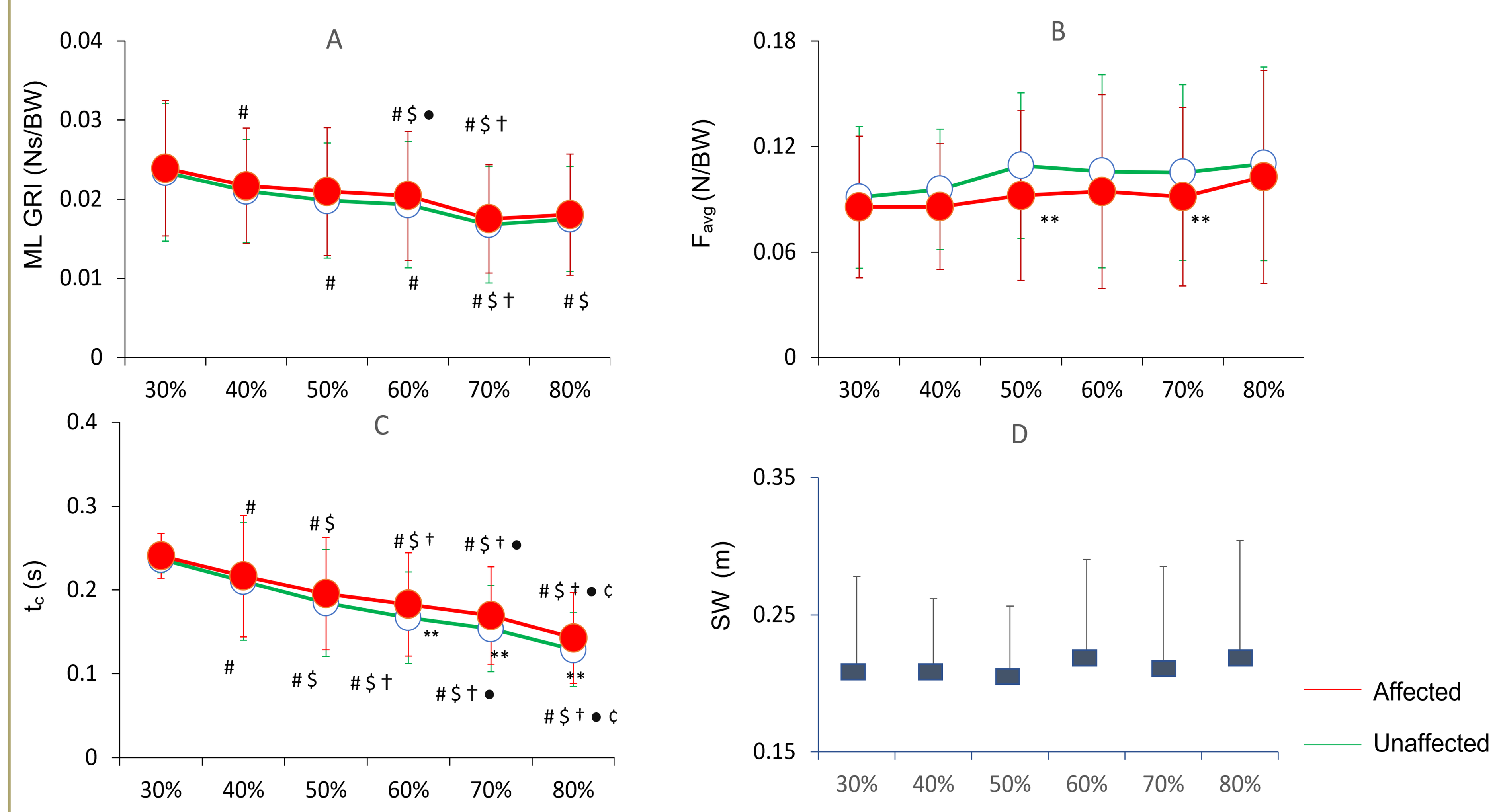

Fig. 1: M-L GRI (A), Favg (B), t_c (C) and SW (D) of the unaffected (*white circles*) and affected (*red circles*) limbs across 6 different running speeds. ** represents significant differences between limbs at each speed at $p < 0.05$. #, $, †, ●, ¢ represent significant differences from 30%, 40%, 50%, 60% and 70% speed trials at $p < 0.05$ respectively

Data analysis

- GRF data filtered at 25Hz
- 14 steps total (7 affected, 7 unaffected)
- Vertical GRF threshold of 40N [3]
- GRF data normalized to bodyweight

Statistical analysis

- One-way, two-way repeated ANOVA
- Friedmen test and Wilcoxon rank sum test

Conclusion

- TFA runners were able to maintain a relatively straight running path through limb specific strategies (difference in the mediation of M-L GRF profile)
- Lower M-L GRI at faster running speeds implied that it is easier to maintain running direction
  - Knowledge can be applied to existing rehabilitation protocol
- Work in progress:
  - Analyzing medial and lateral GRF individually to better understand the interlimb strategies
  - Centre of pressure trajectories to better understand the maintenance of movement direction among the population