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

Tang Ying Wai • Akihiko Murai • Hiroaki Hobara

• University of Tokyo

• Human Augmentation Research Center, National Institute of Advanced Industrial Science

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 path [3]

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 (Favg)
➢ Mediolateral ground reaction impulse (M-L GRI)
➢ Step width (SW)
➢ Contact time(tc)

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 tc 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

Data analysis and Result

Fig. 1: M-L GRI (A), Favc (B), t(c) (C) and SW (D) of the affected (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

References