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Development of IMU System for Measuring 100-m Racing Wheelchair Kinematics

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INTRODUCTION:
Wheelchair racing is one of the major sports events particularly in the Paralympics games. Kinematics analysis of racing wheelchair propulsion (RWP) is critical for improving performance and preventing injury. Previous study investigated RWP kinematics during 100-meter race using 2 video cameras (1). As technology advances, inertia measurement unit (IMU) has currently gained popularity in wheelchair research (2-3) due to its portable, low-cost, and easy to implement. However, no previous study has employed IMU sensors to measure RWP kinematics in the field. Therefore, the purpose of this study was to develop IMU system to measure spatiotemporal parameters during 100-meter distance.
METHODS:
Ten wheelchair racing athletes were volunteered to perform 100-meter race simulation. IMU sensors were attached to the wheelchair frame and both wrists to collect acceleration data for the analysis of RWP kinematics. Furthermore, the traveling distance was measured using an Odometry Measurement Unit (OMU) equipped with an adjustable mechanism for attachment to various sizes of front wheel forks. The acceleration data and traveling distance were collected simultaneously at a sampling frequency of 100 Hz. Three simulated race trials were collected and analyzed. Spatiotemporal data including push frequency, propulsion and recovery phase were obtained from IMU data. Data from a total of 100 meter and each 20-meter interval were analyzed. Repeated measure ANOVA was performed to determine significant differences among the five phases. Holm post hoc tests were completed when a significant main effect was found.
RESULTS:
Significant main effect was found in push frequency ($p<0.001$) and propulsion phase ($p=0.02$), except for recovery phase. Post hoc analyses revealed that there was significant increase in push frequency and propulsion phase when going from first 20 to 20-100 m ($p<0.05$). Similarly, significant increases were also noted with propulsion phase during 0-20 m, however, only when compared to 20-80 m ($p<0.05$).
CONCLUSION:
This study displays the feasibility of IMU system for measuring RWP kinematics in the field. The result shows high push frequency and long propulsion phase in the first 20-meter because athletes need to overcome the inertia from the stationary and gain more velocity. This data can be used to provide feedback to coach and athletes.

REFERENCES:
1. Chow and Chae. J Biomech, 2007
2. Bergamini et al. BioMed Res Int, 2015.
3. Lewis et al. Multidisciplinary Digital Publishing Institute Proc, 2018

Topic: **Biomechanics**

Presentation **Poster**