

Biomechanical Changes in Push and Pull Wheelchair Propulsion in Manual Wheelchair Users

Soonbeom Kim¹, Dongheon Kang^{2,*}, Jiyoung Park³, Eunhae Kang⁴, Jihye Choi², Seon-Deok Eun^{2,*}

¹ Dept. of Clinical Rehabilitation Research, National Rehabilitation Center; ² Assistive Technology Research Team for Independent Living, National Rehabilitation Center; ³ Dept. of Safety and Health, Wonkwang University; ⁴ Dept. of Healthcare and Public Health Research, National Rehabilitation Center

INTRODUCTION

- Many individuals with lower limb disabilities primarily rely on manual wheelchairs for mobility.
- The use of a manual wheelchair requires significant dependence on the upper limbs. Typically, the anterior muscles are used for manual wheelchair propulsion.
- As a result, manual wheelchair users(MWU) frequently experience musculoskeletal disorders related to upper limb joints, such as shoulder impingement syndrome, rotator cuff tears, and rounded shoulders.

OBJECTIVE

- This study aims to compare the kinematics of upper limb joints and the activation of upper limb muscles when propulsion a manual wheelchair using a pulling motion, as opposed to the conventional pushing method.

METHODS

Participants

- 19 individuals with spinal cord injury using manual wheelchairs.
- Classified into elderly(8) and adult(n=11)

Table 1. The general characteristics of participants

Group	Age (y)	Height (cm)	Weight (kg)	Onset (y)	Wheelchair use (y)	Gender (M/F)
Senior	68.63±4.03	165.56±7.43	60.61±12.70	24.79±17.97	22.74±17.19	6/2
Adult	52.09±9.21	169.82±5.33	74.67±13.07	18.99±13.92	16.73±10.22	10/1

Measurement equipment

- VICON 10 camera and wireless sEMG sensors
- Data sampling rate was set to kinematics(100Hz) and muscle activity(2000Hz) to collect data.

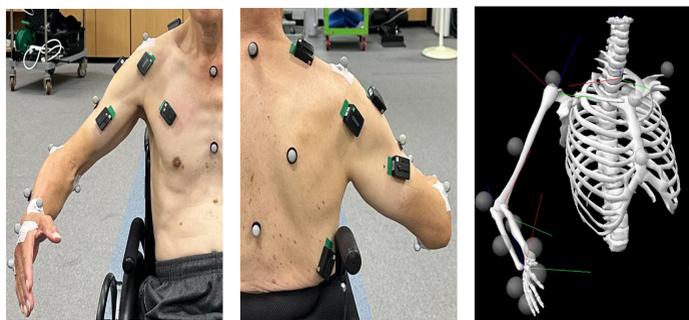


Figure 1. Reflective markers, EMG sensor location and 3D model

Selection of 8 muscle for muscle activity analysis

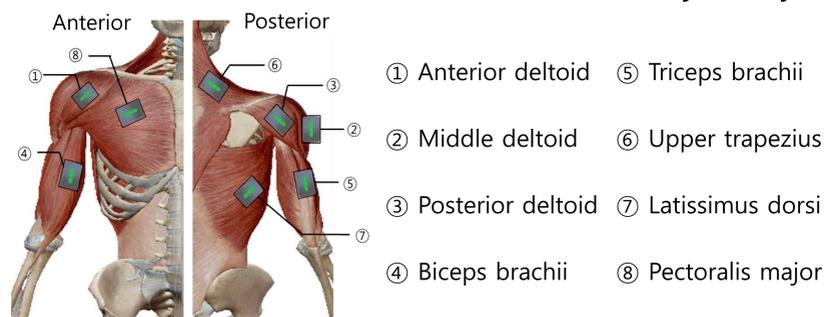
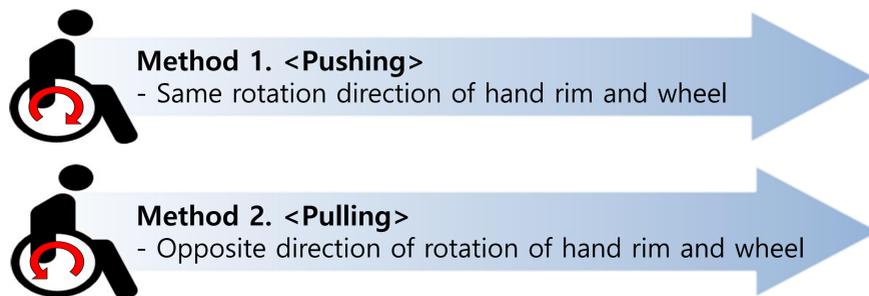


Figure 2. 8 muscle for analysis

Experimental procedure

- The propulsion a 10m flat ground using two different propulsion methods.
- Each methods being tested five trials and three propulsion cycle were used for data processing.

- The used two method of wheelchair propulsion in this study.



RESULTS

Kinematic analysis

- Both groups had an increase in propulsion phase time, but only the elderly groups had a significant increase.
 - Results of the pulling propulsion speed test showed a significant decrease in both groups.
 - Range of motion of the propulsion phase (flex/ext) Shoulder and elbow joint was significant increased in both groups when pulling.
- ### Muscle activation analysis
- AD, PM were high when pushing, but only AD was significantly higher.
 - MD, PD, TB, UT, LD were significantly higher when pulling.
 - BB was high in pulling, but no significance was shown.

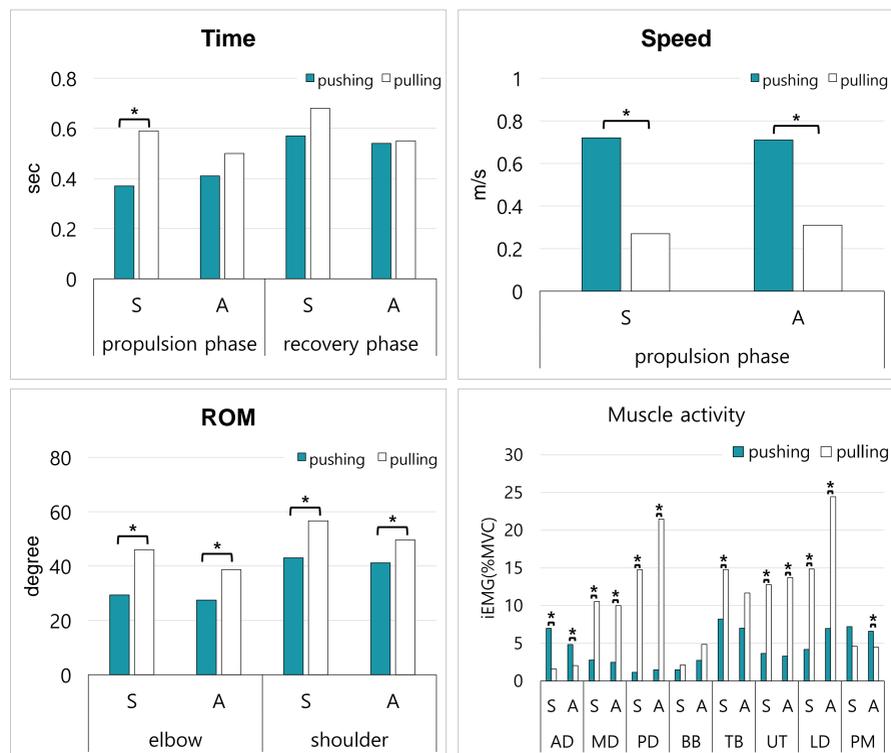


Figure 3. The results of kinematics and muscle activity analysis(iEMG)
S: senior group, A: adult group

CONCLUSION

- The analysis of kinematics and EMG data confirmed that pulling propulsion increased posterior muscle activation and joint ROM.
- MWU frequently engage their anterior muscle due to repetitive unidirectional movement, strengthening the posterior muscle is necessary.
- Using a manual wheelchair with a pulling propulsion method in daily life may provide exercise and rehabilitation benefits.

*Corresponding Authors: Dongheon Kang(luxpooh@gmail.com); Seon-Deok Eun(esd7786@korea.kr)

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