Measurement of (1) shoulder muscle activity and (2) hand/handrim contact force used in one arm drive wheelchairs: A comparison of the Neater Uni-wheelchair to other contemporary one arm drive wheelchairs.

Abstract

Purpose: The aim of this study was twofold:

1. To compare the hand/handrim forces generated in three different manual one arm drive wheelchairs: a NuDrive lever drive, the Neater Uni-wheelchair and an Action3. All three wheelchairs used the Neater Uni-wheelchair steering mechanism to permit one armed propulsion. The *Grip*™ system was used to measure dynamic interface grip force between the propelling hand palm, thumb and fingers and the wheelchair handrim.
2. To measure muscle activity using EMG in six muscles around the shoulder during propulsion of the same three different one arm drive wheelchairs.

Methods: 17 non-disabled users were randomly assigned each wheelchair to drive around an indoor obstacle course. During propulsion a multiple sensor, continuous measurement of force was recorded at the hand/handrim interface. Time taken to complete each part of the circuit was recorded. Mean force for each segment of the hand and total force were calculated per user per wheelchair. The EMG data was measured using the biometrics data link system v 7.5 and the data was measured at 1000 Hz. The EMG electrodes were attached according to Seniam guidelines.

Results from the Grip Study: The greatest total hand/handrim interface force was generated during propulsion of the NuDrive lever wheelchair in straight running (Friedmans X^2=15.647, n=17, df=2, p<0.001) and in the slalom (Friedmans X^2 = 7.882, n=17, df=2, p<0.019). There was no difference in force generation over the mats.

Results exploring the force distribution within the hand indicated that there was a significant difference in force exerted in different regions of the hand in different wheelchairs in straight running. The Neater uni-wheelchair generated the lowest forces across the palm, fingers and thumb F(4,26)=11.489, MSE=0.993, p<0.001. The NuDrive generated a significantly higher force in the fingers (p<0.032) and palm (p<0.019) than the other two wheelchairs.

Results from the EMG Study:

The table identifies within which muscles and during which activity, differences in muscle activity occurred.

Activity	Biceps	Triceps	Ant Deltoid	Post Deltoid	Pectoralis Major	Infra-spinatus
Running	NSD	p<0.01	NSD	NSD	NSD	NSD
Mats	p<0.001	NSD	NSD	NSD	p<0.001	NSD
Slalom	p<0.001	NSD	NSD	NSD	p<0.01	NSD

Conclusions for The Grip Study: Total force generation was greatest in the NuDrive lever wheelchair during propulsion in straight running (p<0.019) and also when propelling around the slalom (p<0.006).

Analysis of the component forces suggested that the NuDrive wheelchairs generated significantly higher force in the palm (p<0.05) and the fingers (p<0.03) than the other two wheelchairs.

This suggests that the grip used in propelling using a handrim and using the levers is different resulting in a different application of force. Propulsive force may be related to repetitive strain and overuse injury which may be a factor to consider in wheelchair prescription.

Conclusions for the EMG Study: The NuDrive produces the greatest levels of activity in Biceps and Pectoralis Major over mats and during the slalom. The Neater Uni-wheelchair produces the least levels of activity in Biceps and Pectoralis Major over mats and during the slalom. The Action 3 produced the greatest levels of activity in Triceps during straight running.

Implications for Practice: To review the clinical reasoning in prescribing lever drive wheelchairs.

To improve clinicians understanding of forces incurred in wheelchair propulsion

To illuminate clinicians understanding of the causation of repetitive strain injury in the upper limb of hemiplegic wheelchair users