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Shoulder Joint Load during Lever Wheelchair Propulsion in Individuals with SCI

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Objective: To compare the shoulder joint kinematics and kinetics recorded during standard pushrim wheelchair propulsion (Standard) and lever propulsion (Lever).

Design: Experimental – multivariate analysis of variance

Participants/methods: Fourteen males with complete (ASIA-A) spinal cord injury (SCI) participated. Subjects represented 2 groups of SCI level: paraplegia (n=6) and tetraplegia (n=8). Upper extremity reaction forces were recorded using an instrumented pushrim (SmartWheel) and instrumented lever during Standard and Lever propulsion, respectively. Upper extremity kinematics were recorded with a 6-camera VICON system. Reaction forces and kinematics were recorded while subjects propelled a wheelchair mounted to a stationary ergometer. Data were recorded at self-selected free (FR) and fast (FT) speeds and at a simulated 8% grade (GR). Speed in Lever was matched with Standard in each test condition. Shoulder net joint forces, moments, and kinematics were determined using an inverse dynamics algorithm in Visual3D.

Results: Superior shoulder force was significantly ($p<0.05$) lower in the Lever (FR: -19N vs. 5N; FT: -14N vs. 20N; GR: 7N vs. 41N). The posterior shoulder force was lower in Lever during FR (27N vs. 34N) and FT (43N vs. 68N) but greater during GR (106N vs. 80N). During push, peak flexion position was 10^o to 13^o greater, adduction excursion was 7^o to 9^o greater, and internal rotation was 9^o to 14^o greater in Lever compared to Standard. Peak flexor moment was lower in Lever but was significant only during FT (11Nm vs. 24Nm). Subjects with paraplegia had significantly greater speed (FR: 74m/s vs. 53m/s; FT: 143m/s vs. 81m/s; GR: 63m/s vs. 29m/s), less push duration (FR: 0.30s vs. 0.45s; FT: 0.17s vs. 0.29s; GR: 0.44s vs. 0.79s) and greater superior shoulder forces than subjects with tetraplegia.

Conclusion: Lever propulsion shifted the shoulder joint load by decreasing the superior glenohumeral force while increasing the range of motion.

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