

EVALUATION OF HAND-RIM AND WRIST JOINT KINETICS DURING GEARED MANUAL WHEELCHAIR PROPULSION IN VETERANS WITH SPINAL CORD INJURY

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ABSTRACT

The purpose of this study was to quantify the effects of using geared wheels on hand-rim and wrist joint kinetics during manual wheelchair propulsion in individuals with spinal cord injury. Seven veterans with spinal cord injury propelled their wheelchairs equipped with geared wheels over a carpeted floor in low gear (1.5:1) and standard gear (1:1) conditions. An instrumented geared wheel measured hand-rim kinetics. Tri-axial wrist joint dynamics were calculated using Vicon motion analysis and our established biomechanical model. The peak hand-rim resultant force, maximum rate of force application, and propulsive moment, as well as peak anterior and inferior wrist forces, and flexion, adduction and internal rotation moments were significantly less during the low gear condition than the standard gear condition. The geared wheels have proven to significantly decrease wrist joint forces and moments during wheelchair propulsion, which may ultimately reduce the risk of musculoskeletal injuries common in wheelchair users, such as carpal tunnel syndrome. The current investigation suggests that using geared wheels may be effective in reducing the risk factors of secondary upper extremity injuries in manual wheelchair users. Ultimately this assistive technology may enhance wheelchair users' home and community mobility.

Keywords: geared wheel; manual wheelchair mobility; wrist joint biomechanics; carpal tunnel syndrome; rehabilitation

INTRODUCTION

Manual wheelchair users are dependent on their upper limbs for mobility, transfers, pressure relief and activities of daily living. Injury to the upper limbs and pain could significantly deteriorate their quality of life. Among manual wheelchair users with spinal cord injury (SCI), the hand-wrist area is one of the most common sites of pain and injury [1-3]. Carpal tunnel syndrome is a major cause of wrist and hand pain in manual wheelchair users with SCI [1, 2]. The prevalence of carpal tunnel syndrome in this population has been reported up to 67% [2, 4-5].

Previous studies on paraplegic manual wheelchair users have shown that in contrast to the general population, carpal tunnel syndrome symptoms were bilateral [1, 2]. These studies have linked the high prevalence of the hand and wrist injuries in manual wheelchair users with SCI to specific aspects of wheelchair use. The repetitive weight bearing and mobility activities unique to the wheelchair user are among the major risk factors for incidence of carpal tunnel syndrome [6, 1-2]. High repetitive loading of the upper limbs and poor wrist posture during manual wheelchair propulsion are correlated with injuries and pain at the hand and wrist in manual wheelchair users [2]. Individuals with SCI are recommended to minimize the forces to complete a task [7]. Previous studies have shown that the reduction of propulsion