The Relationship between Power and Manual Wheelchair Mobility and Upper Extremity Pain in Youths with Low Level Cervical Spinal Cord Injury

Prepared by: Kaitlin MacDonald, MOT, OTR/L¹, Stephanie Ramey, MS, OTR/L¹, Rebecca Martin, OTR/L, OTD¹ and Glendaliz Bosques¹,², MD

¹The International Center for Spinal Cord Injury at Kennedy Krieger Institute, Baltimore, MD; ²Johns Hopkins School of Medicine, Department of Physical Medicine and Rehabilitation, Baltimore, MD

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CLINICAL SCENARIO: For individuals with spinal cord injuries, the demands placed on the upper extremity change secondary to the need to compensate for lower extremity weakness and/or paralysis. Excessive weight-bearing and repetitive strain is often necessary for participation in activities of daily living and mobility, including propulsion of a wheelchair. Because the joints of the upper extremity are not designed for this type of use, pain is prevalent among individuals with spinal cord injuries. Upper extremity pain can have a significant impact on independence and quality of life. The method of wheelchair propulsion may have an impact on the incidence of pain among youths with cervical spinal cord injuries.

FOCUSED CLINICAL QUESTION: For youths with low level cervical spinal cord injury, how does use of power wheeled mobility compare with manual wheeled mobility on shoulder, elbow and wrist pain?

CLINICAL BOTTOM LINE:
- Individuals with cervical spinal cord injuries are at higher risk for shoulder and elbow pain. Incidence of pain is associated with time from initial injury and age.
- Pain is prevalent among power and manual wheelchair users with spinal cord injuries, as well as community ambulators who require the use of assistive devices.
- Upper extremity pain may be associated with muscle imbalances and changes in biomechanics.
- Further research is necessary to examine the effects of mechanical and non-mechanical factors on pain in youths with spinal cord injury. Minimal and inconsistent evidence is available regarding the relationship between the method of wheelchair propulsion and pain.

SUMMARY of Search, ‘Best’ Evidence’ appraised, and Key Findings: 5 articles met inclusion criteria and helped answer clinical question best:
  - There is a high prevalence of shoulder pain in persons with SCI. While this pain has previously been attributed to overuse injuries with manual wheelchair use, the authors of this article found that shoulder pain was also elevated in those using power mobility as well as ambulation devices.

  - All 3 activities examined (level propulsion, ramp propulsion, and during a pressure relief) placed the scapula in positions that can potentially lead to shoulder impingement
injuries. The pressure relief lift, not manual wheelchair propulsion, places wheelchair users at the greatest risk for soft tissue injury.


- Significantly lower energy cost and increased distance are associated with the use of power-assisted wheelchairs


- Of the 216 participants in this study (all above the age of 24) with pediatric onset spinal cord injury who were interviewed, 48% had shoulder pain and 15% had elbow pain.
- Shoulder and elbow pain increased with time from initial injury and with age.


- 72.7% of subjects reported wrist and/or shoulder pain. Age, time since injury, and neurological level were not statistically significant.
- Subjects reported that wheelchair propulsion and transfers caused the most pain.

Limitation of this CAT: This critically appraised topic has not been peer-reviewed by another independent person.

SEARCH STRATEGY:
- Patient/Client Group: Youths with low level cervical spinal cord injury, birth through age 16
- Intervention (or Assessment): Power and manual wheelchair mobility
- Comparison: Methods of mobility were compared with the focus on the relationship to pain
- Outcome(s): Incidence of pain

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<th>Databases</th>
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<td>Pub Med</td>
<td>Spinal cord injury, youth, pediatric, pain, shoulder pain, upper extremity pain, wheelchair, power wheelchair, manual wheelchair, power-assist wheelchair, power mobility, manual mobility, power-assist mobility</td>
<td>English language, Humans</td>
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INCLUSION and EXCLUSION CRITERIA:
- Inclusion: Peer-reviewed literature on the relationship between wheelchair propulsion methods and pain in adult or pediatric individuals with spinal cord injury.

- Exclusion: Articles from non-peer reviewed sources or without scientific merit were excluded from review. Study populations including wheelchair users with other diagnoses and articles published prior to 1992 were also excluded.

BEST EVIDENCE: The following studies were identified as the 'best' evidence and selected for critical appraisal. Reasons for selecting these studies were: Jain et al. (2010) and Morrow et al. (2011) found statistically significant evidence that the level of injury directly correlates to increased pain from a biomechanical perspective. Nash et al. (2008) investigated the impact of power-assisted mobility on pain and energy cost. Vogel et al. (2002) studied the impact of time since injury of pediatric onset spinal cord injury on pain. Subbarao et al. (1995) describes the individual’s perception of the cause of his or her pain.
SUMMARY OF BEST EVIDENCE

Association of Shoulder Pain with the Use of Mobility Devices in Persons with Chronic Spinal Cord Injury (Jain et al., 2010)

Aim/Objective of the study: To determine the impact of mobility devices on shoulder pain in individuals with chronic spinal cord injuries

Design: Cross-sectional analysis conducted within a cohort study

Setting: Community, spinal cord injury service in a hospital

Participants: 93 adults with chronic spinal cord injuries

Outcome Measures: Participants completed a standardized health questionnaire and pain questionnaire

Results: Pain was reported by 69.6% of participants in the 6 months before testing. After legs and back, shoulder pain was the third most common area of pain. Shoulder pain was reported by 46.7% of motorized wheelchair users, 35.4% of manual wheelchair users, 47.6% of participants ambulating with assistive devices, and 33.3% of participants walking without assistive devices.

Conclusion: Shoulder pain is highly prevalent among individuals with spinal cord injury. Manual wheelchair propulsion may not be the cause of shoulder pain, as high incidence of pain was reported in all groups, including motorized mobility users and ambulators.

Scapula Kinematics and Associated Impingement Risk in Manual Wheelchair Users during Propulsion and Weight Relief Lift (Morrow et al., 2011)

Aim/Objective of the study: To assess scapulothoracic and glenohumeral kinematics during wheelchair propulsion and pressure release lifts

Design: Cohort Study

Setting: Biomechanics and Motion Analysis Laboratory at the Mayo Clinic (Rochester, MN)

Participants: 12 adult manual wheelchair users with normal functioning shoulder musculature, 11 participants with spinal cord injuries and one with spina bifida

Procedures: Scapula, humerus, and trunk kinematics were measured for 12 manual wheelchair users over three conditions: level propulsion, ramp propulsion, and a weight relief lift.

Outcome Measures: Scapulothoracic and glenohumeral kinematics

Results: The results indicated that an externally rotated glenohumeral joint and an anteriorly tilted and internally rotated scapula occurred during all of the activities examined. The weight relief lift displayed significantly less external rotation at peak loading when compared to level and ramp propulsion.

Conclusion: The weight relief lift placed the scapula in a position that puts the individual at risk for shoulder injury. The weight relief lift may play a larger role in shoulder pain than manual wheelchair propulsion.

Power-Assisted Wheels Ease Energy Costs and perceptual Responses to Wheelchair Propulsion in Persons with Shoulder Pain and Spinal Cord Injury (Nash et al., 2008)

Aim/Objective of the study: To study the effects of power-assisted wheelchair propulsion on energy and perception of pain among individuals with tetraplegia and paraplegia having chronic shoulder pain

Design: Test, re-test with a control condition

Setting: Academic medical center

Participants: 18 subjects aged 19-70 years with chronic, motor-complete tetraplegia or paraplegia having confirmed shoulder pain

Procedures: Participants used their own wheelchairs with customary wheels or power assist wheels to complete 6 minutes of steady-state or 12 minutes of intensity-graded wheelchair propulsion in stationary rollers on 4 separate days.

Outcome Measures: Oxygen consumption, distance, energy cost, and ratings of perceived exertion

Results: Distances propelled was increased while energy cost and perceived exertion were decreased with the use of power-assist wheels.
Conclusion: The use of power-assist wheels by persons with paraplegia and tetraplegia having shoulder pain significantly lowers energy cost and perceived exertion compared with manual wheelchair propulsion while significantly increasing the distance propelled.

Adults with Pediatric-Onset Spinal Cord Injury: Part 2: Musculoskeletal and Neurological Complications (Vogel et al., 2002)

Aim/Objective of the study: To examine the significance of musculoskeletal and neurological complications of adults with pediatric-onset spinal cord injuries

Design: Structured interview

Setting: Shriners Hospital for Children, Chicago, IL

Participants: 216 participants who were over 24 years of age, who were initially injured under the age of 18

Procedures: Participants completed a telephone interview to determine demographics and musculoskeletal and neurological status. Subjects were grouped based on American Spinal Injury Association motor scale. Functional and sociocognitive statuses were also assessed through phone interview.

Outcome Measures: The prevalence of musculoskeletal and neurological complications including: shoulder pain, elbow pain, elbow contractures, fractures in the last 3 years, heterotopic ossification, scoliosis, hip dislocation or contractures, ankle pain or contracture, pain at other sites, neurological deterioration, syringomyelia, and spasticity since injury

Results: 48% of participants had shoulder pain, 15% had elbow pain. Longer duration of injury was associated with increased incidence of shoulder and elbow pain. Of the individuals who reported shoulder pain, 21% reported that the pain limited participation in activities. Pain is significantly increased in individuals with spasticity.

Conclusion: Shoulder and elbow pain is associated with time from initial injury and age.

Prevalence and Impact of Wrist and Shoulder Pain in Patients with Spinal Cord Injury (Subbarao et al., 1995)

Aim/Objective of the study: Concluding which activities increased wrist and shoulder pain in individuals with spinal cord injuries, how individuals responded to pain, and to begin assessing ways to decrease the pain.

Design: Survey

Setting: Community dwelling individuals

Participants: 800 spinal cord injury patients were initially surveyed, with 451 responding; 30 patients were available for clinical observation and evaluation

Outcome Measures: Wrist and shoulder pain; data was evaluated using the Statistical Analysis System and the Cornell Personal Adjustment Scale

Results: Wrist and shoulder pain is increased in individuals with spinal cord injury. The two activities that exacerbated the pain were propulsion and transfers.

Conclusion: There is a need to further investigate ways to decrease the repetitive trauma and stress that propulsion of a wheelchair and transfers places on wrist and shoulders, for patients with a spinal cord injury.

IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARCH

Practice:
- Thorough assessment of scapulothoracic and glenohumeral biomechanics during functional activities is imperative, as non-mechanical factors may play a larger role in the development of shoulder pain than wheelchair mobility. Wheelchair propulsion recommendations should be based on the results of biomechanical assessment.
- Many research studies report a high incidence if upper extremity pain among individuals with spinal cord injuries. Emphasis should be placed on prevention of pain through the use of home rehabilitation programs for strengthening for shoulder stability. Some research suggests that power-assist wheelchair propulsion may aid in the delay, prevention, or decreased severity of shoulder pain.

Education:
• It is necessary to educate individuals with paraplegia and tetraplegia about the incidence of pain in spinal cord injury and the importance of prevention through preservation of the shoulders.

• Education is necessary for new therapists and students regarding the impact of altered kinematics resulting from muscle imbalance and postural deformity, as well as wheelchair propulsion and pressure reliefs, on pain. Power-assist wheels may be an important tool in decreasing the incidence and severity of shoulder pain.

Research:
• Conflicting information can be found in the available literature on wheelchair propulsion methods and their relationship to pain.

• More evidence on the incidence and causes of pain in among youths with spinal cord injury is needed.

• Much of the research on pain in spinal cord injury is focused on the shoulder. More evidence is needed in order to understand the incidence, causes, and impact of pain throughout the upper extremity, including the elbow and wrist.