

**ORIGINAL RESEARCH**

# Agreement of Musculoskeletal Ultrasound and Clinical Assessment of Shoulder Impairment in Manual Wheelchair Users With Various Duration of Spinal Cord Injury



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## Abstract

**Objectives:** To determine (1) agreement of musculoskeletal ultrasound (MSK-US) findings of shoulder pathology and related shoulder special test results in individuals with varied durations of manual wheelchair (MWC) use after spinal cord injury (SCI); and (2) whether shoulder musculoskeletal impairments, per MSK-US and clinical examination, differed in individuals with SCI and varying durations of MWC use.

**Design:** Cross-sectional cohort study.

**Setting:** Laboratory setting.

**Participants:** Adult volunteers (N=23) with SCI who used an MWC for community mobility. Individuals were stratified into 3 groups based on duration of MWC use: <5 years, 5 to 15 years, and >15 years.

**Interventions:** Not applicable.

**Main Outcome Measures:** Special tests for shoulder impingement and bicipital tendonitis were performed. Bilateral shoulder MSK-US was performed, with the Ultrasound Shoulder Pathology Rating Scale (USPRS) quantifying biceps tendon, supraspinatus tendon, and greater tuberosity cortical surface impairments.

**Results:** No agreement was found between MSK-US and related special tests. Special tests failed to identify impairment in 33.3% to 100% of those identified on MSK-US. The total USPRS score was highest in those with >15 years' MWC use. A higher proportion of dynamic impingement (supraspinatus and biceps) was found in those with >15 years' MWC use, with other MSK-US items having moderate effect sizes among duration-use groups.

**Conclusions:** MSK-US identified shoulder impairments more frequently than commonly used special tests. A significant increase in the presence of MSK-US shoulder impairments was identified in the longest-duration group. This was not the case for special tests or pain. MSK-US is an easily administered, low-cost, noninvasive method for determining shoulder impairments and should be used in routine screening of individuals who use an MWC after SCI.

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More than 282,000 people in the United States are living with a spinal cord injury (SCI). The annual incidence is approximately 54 cases per million, or 17,000 new cases each year.<sup>1</sup> Nearly 40%

of individuals with SCI use a manual wheelchair (MWC) for mobility.<sup>1</sup> Advantages of using an MWC include promotion of physical fitness<sup>2</sup> and greater transportability.<sup>3</sup> The downside is that MWC use places significant demands on the upper extremities (UEs).<sup>4</sup> This population also uses their UEs for transfers, pressure relief, and many other daily activities. Such dependence on their UEs potentially predisposes them to debilitating UE problems.<sup>5-7</sup>

The prevalence of shoulder pain in the general population is between 7% and 26%.<sup>8</sup> Prevalence is notably higher in individuals

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with SCI,<sup>6,9-11</sup> where more than two thirds of MWC users report having experienced shoulder pain.<sup>10,12-15</sup> A higher proportion of MWC users with tetraplegia report experiencing shoulder pain compared with those with paraplegia.<sup>16</sup> Shoulder pain is reported as early as 1 year after SCI,<sup>17,18</sup> and early onset is predictive of persistent long-term pain.<sup>18</sup> Furthermore, 3 trajectories of shoulder pain in people with SCI have been identified: (1) consistent high pain; (2) consistent low pain; and (3) high pain during rehabilitation, which then decreases.<sup>19</sup> The specific etiology of shoulder pain is variable in persons with SCI. Chronic subacromial impingement syndrome,<sup>5,20,21</sup> inflammatory conditions,<sup>11</sup> joint degeneration,<sup>22,23</sup> instability,<sup>24</sup> and bicipital tendonitis<sup>6,20</sup> are most commonly reported. Additionally, the prevalence of full-thickness rotator cuff tears is higher in MWC users with SCI than in able-bodied individuals when matched for sex and age (63% vs 15%).<sup>25</sup>

Management of shoulder pain in individuals with SCI occurs after the onset of pain as opposed to beforehand. Clinicians use findings from the history and clinical examination to guide intervention decisions. However, special tests commonly used in the clinical examination have questionable diagnostic accuracy.<sup>26-28</sup> Application of multiple special tests may yield a more accurate diagnosis, though even this approach leaves a great deal of diagnostic uncertainty.<sup>27,29</sup>

Radiographs have identified degenerative shoulder abnormalities,<sup>23</sup> while arthrography and magnetic resonance imaging have documented rotator cuff tears in individuals with SCI.<sup>5,21,24,30</sup> These diagnostic procedures can be painful, invasive, time-consuming, and costly. Musculoskeletal ultrasound (MSK-US) is a less expensive, less time-consuming option that allows for static and dynamic evaluation of shoulder structures. A recent meta-analysis<sup>31</sup> confirms similar and high diagnostic accuracy of MSK-US, magnetic resonance imaging, and arthrography in characterizing full-thickness rotator cuff tears.

The prospective surveillance model<sup>15</sup> provides a unique conceptual framework that can guide research focused on decreasing shoulder pain and dysfunction in the SCI population. The model has provided a framework for management of breast cancer survivors, focusing on early detection and reduction of secondary impairments and enhancement of return to essential and desired life activities.<sup>15</sup> MSK-US as a routine extension of the clinical examination can expedite diagnosis, thus allowing for timely initiation of impairment-specific treatments.<sup>29</sup> However, limited information exists regarding MSK-US for identifying shoulder impairments in MWC users with varied durations of SCI.

MSK-US identified supraspinatus tendinopathy and humeral cortical irregularity in >90% of long-term wheelchair users.<sup>32</sup> Additionally, several MSK-US findings were significantly associated with positive clinical examination findings.<sup>32</sup> However, this study investigated a homogeneous population (athletic men with

SCI duration >16y). There is a need to study the association of shoulder MSK-US findings with clinical examination outcomes in a heterogeneous population of individuals with SCI. Therefore, the primary purpose of this study was to compare agreement of shoulder MSK-US and special test findings in individuals with varied durations of MWC use after SCI. The secondary purpose was to determine whether shoulder musculoskeletal impairments, per MSK-US and clinical special test findings, differed in individuals with SCI and varying durations of MWC use. We hypothesized that (1) MSK-US would reveal a higher proportion of positive findings (impairment) than matched special tests; and (2) MSK-US and special test findings in participants with a longer duration of MWC use would be more numerous than those with a shorter duration of MWC use.

## Methods

### Study design

A cross-sectional cohort study with between group comparisons was approved by the institutional review board at Drexel University. All participants provided informed consent.

### Participants

Twenty-three adult volunteers with SCI who used an MWC for community mobility participated. Individuals were eligible for participation if they had a history of SCI and self-reported MWC use for at least 75% of community mobility. Exclusion criteria included UE radicular symptoms; preexisting neurologic conditions; UE fracture, dislocation, or surgery; or health conditions that could influence UE function. Participants provided information on age, sex, hand dominance and details of their SCI (injury level), description of wheelchair specifics, and daily activities.

To quantify and describe physical activity levels, each participant completed the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD).<sup>33,34</sup> The weight and height of participants were measured, and body mass index (BMI) was calculated ( $BMI = \text{weight}/\text{height}^2$ ). The Wheelchair Users Shoulder Pain Index (WUSPI)<sup>35,36</sup> quantified shoulder pain.

### Study measures

One investigator (M.F.), a physical therapist with over 30 years of orthopedic clinical experience, performed a clinical shoulder examination on all participants. This examination included bilateral measures of active range of motion (goniometric), muscle strength (hand-held dynamometry), special tests for specific shoulder pathologies, and palpation of various structures. Only the results of the special tests are relevant to the purposes of this article. The special tests performed in a random order were the Neer<sup>37</sup> and Hawkins-Kennedy<sup>38</sup> impingement tests (subacromial impingement syndrome) and Speed's test<sup>39</sup> (bicipital tendonitis/tendinosis). Participant report of pain during these tests was recorded as a "positive" finding, and absence of pain was "negative."

Bilateral shoulder MSK-US was performed with a multifrequency, broadband, 50-mm linear array transducer.<sup>a</sup> Participants were seated in their personal wheelchair while a series of shoulder images<sup>32,40</sup> were obtained. These included integrity of the subscapularis, supraspinatus, infraspinatus, and biceps tendons, and

#### List of abbreviations:

<b>BMI</b>	<b>body mass index</b>
<b>MSK-US</b>	<b>musculoskeletal ultrasound</b>
<b>MWC</b>	<b>manual wheelchair</b>
<b>PASIPD</b>	<b>Physical Activity Scale for Individuals with Physical Disabilities</b>
<b>SCI</b>	<b>spinal cord injury</b>
<b>UE</b>	<b>upper extremity</b>
<b>USPRS</b>	<b>Ultrasound Shoulder Pathology Rating Scale</b>
<b>WUSPI</b>	<b>Wheelchair Users Shoulder Pain Index</b>

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