

**ORIGINAL ARTICLE**

# Do Overhead Sports Increase Risk for Rotator Cuff Tears in Wheelchair Users?



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**Abstract**

**Objective:** To analyze whether frequent overhead-sports activity increases the risk for rotator cuff disease in patients with spinal cord injuries (SCIs) who are wheelchair dependent.

**Design:** Cross-sectional study, risk analysis.

**Setting:** Department of Orthopaedic Surgery, Trauma Surgery and Spinal Cord Injury.

**Participants:** Patients (N = 296) with SCI requiring the full-time use of a manual wheelchair were recruited for this study. The total population was divided into 2 groups (sports vs no sports), among them 103 patients playing overhead sports on a regular basis (at least 1–2 times/wk) and 193 patients involved in overhead sports less than once a week or in no sports activity at all. The mean age of the sports group was 49.1 years. The mean duration of wheelchair dependence was 26.5 years. The mean age of the no-sports group was 48 years. The mean duration of wheelchair dependence was 25.2 years. Each individual completed a questionnaire designed to identify overhead-sports activity on a regular basis and was asked about shoulder problems. Magnetic resonance imaging scans of both shoulders were performed in each patient and analyzed in a standardized fashion.

**Interventions:** None.

**Main Outcome Measures:** Possible differences in continuous data between patients with and without rotator cuff tear were evaluated. The relative risk of suffering from a rotator cuff tear between patients playing overhead sports and those not playing overhead sports was calculated.

**Results:** One hundred three patients played overhead sports regularly and 193 did not. There was no difference between groups regarding age, sex, level of SCI, and duration of wheelchair dependence. The body mass index was significantly lower in the sports group than in the no-sports group ( $P < .0001$ ). A rotator cuff tear was present in 75.7% of the patients in the sports group and in 36.3% of the patients in the no-sports group ( $P < .0001$ ). Rotator cuff tears were symptomatic in 92.6% of the patients. The estimated risk increase for the sports group to develop rotator cuff tears was twice as high as for the no-sports group (95% confidence interval, 1.7–2.6;  $P < .001$ ). Similar results were found for the neurological level of lesion (T2–7/T7), where the estimated risk was about 2.3 times higher in patients with a high neurological level of lesion (T2–7) than in those with a low neurological level of lesion (<T7) (95% confidence interval, 1.82–3.04;  $P < .001$ ).

**Conclusions:** Overhead-sports activities have been identified as an additional risk factor, along with age and duration of wheelchair dependence, for developing rotator cuff disease in patients with paraplegia. A high frequency of sports activity shows physiological benefits as well as improves the psychological status and quality of life in patients with SCI. The dilemma is how to increase physical activity to gain physiological and psychological health benefits without further increasing overuse of the upper extremities, particularly the shoulder, in patients with paraplegia. The data from this study may be helpful in elucidating the etiology of rotator cuff tear in athletes with paraplegia and in counseling patients with SCI regarding shoulder and upper extremity activity level and provide support for developing preventive strategies.

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In the last 2 decades, the shoulder girdle in athletes has become a distinctive specialty in clinical sports medicine.<sup>1</sup> Overhead sports such as volleyball and tennis are very popular in the healthy population. However, an increased risk of developing shoulder problems such as pain and loss of strength has been described for athletes who play overhead sports.<sup>1-8</sup> Moreover, structural changes in the rotator cuff have been observed in different investigations in these athletes.<sup>1,5-8</sup> In general, acute shoulder girdle lesions with macrotraumas need to be distinguished from a chronic shoulder pathology due to overuse and recurrent microtrauma.<sup>1-4</sup> In general, 2 different entities of impingement syndromes have been described for athletes playing overhead sports. The so-called outlet impingement leads to a contact between the bursa side of the rotator cuff and greater tuberosity against the acromion. The inlet impingement has been defined as the contact of the articular side of the rotator cuff against the posterosuperior region of the labrum and glenoid. Based on the repetitive contact between tendons and bone and repetitive microtrauma and tensile overload, both impingement types can lead to rotator cuff tears (RCTs).<sup>9-12</sup>

Patients who are paraplegic as a result of spinal cord injury (SCI) are wheelchair dependent and frequently use their arms overhead. Although these patients have an SCI, many of them are actively participating in sports. The consensus in the scientific literature is that repetitive motion, over-the-head reaching from a wheelchair position, and/or overuse are responsible for shoulder problems when living with an SCI.<sup>13-16</sup> Patients with SCI who are wheelchair dependent are using their arms regularly above the shoulder level and have high loads on their shoulders because of wheelchair propulsion and activities of daily living. It is not clear whether additional overhead-sports activities may increase the risk for shoulder problems and especially rotator cuff disease.

As far as we know, no studies have evaluated the relation between pathological conditions in the shoulder of patients with paraplegia who are active in sports.<sup>1</sup>

Therefore, the hypothesis of the present study is that for the aforementioned reasons patients with paraplegia are at a risk for developing pathologic changes in their shoulders when playing overhead sports.

## Methods

### Study design

After obtaining institutional review board approval, a computerized database search for patients with paraplegia was performed. Once the patients were identified, information including age, sex, date of SCI, total time of wheelchair dependence, previous operative procedures, and injuries of the upper extremities was obtained by reviewing the medical records. These patients were contacted by mail and asked to participate in this study. Of 500 wheelchair users with paraplegia, 317 met the inclusion criteria (table 1) and were recruited for this study. Portions of the data from these patients have been used in recently published studies<sup>13,17</sup>; however, these studies focused on other topics and the influence of overhead sports on rotator cuff disease has not been analyzed. The present subanalysis is therefore unique and has not

**Table 1** Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> <li>Paraplegia</li> </ul>	<ul style="list-style-type: none"> <li>Contraindications for magnetic resonance imaging</li> </ul>
<ul style="list-style-type: none"> <li>Wheelchair dependent 24/7</li> </ul>	<ul style="list-style-type: none"> <li>Cervical disc herniation, advanced degenerative disease of the spine</li> </ul>
<ul style="list-style-type: none"> <li>Wheelchair dependent &gt;5y</li> </ul>	<ul style="list-style-type: none"> <li>Cervical and thoracic syringomyelia</li> </ul>
<ul style="list-style-type: none"> <li>Mentally healthy, no brain injury</li> </ul>	<ul style="list-style-type: none"> <li>History of soft tissue injury of the upper extremity</li> </ul>
<ul style="list-style-type: none"> <li>Complete information regarding overhead-sports activity</li> </ul>	<ul style="list-style-type: none"> <li>Active infection of the shoulder</li> <li>Previous surgery of the upper extremity</li> </ul>

previously been published. Each individual was asked to complete a questionnaire designed to identify overhead-sports activity on a regular basis (at least 1–2 times/wk). Twenty-one (6.6%) of the 317 patients were excluded because of incomplete data. A total of 296 patients with paraplegia (58 women and 238 men) were ultimately included in the study. Before enrollment patients gave their written informed consent to participate in the study.

### Clinical evaluations

Clinical evaluations included measurement of active forward flexion and external rotation, with the arm hanging at the side and the elbow flexed at 90°, by using a goniometer. External rotation strength, as an indicator for infraspinatus muscle function, was tested simultaneously on both sides, with hanging arms and elbows flexed at 90° against the resistance of the examiner. Moreover, the Jobe test for the supraspinatus muscle and the lift-off test for the subscapularis muscle were performed.

The visual analog scale was used to measure current pain, with 0 indicating no shoulder pain and 100 indicating the most severe pain. A symptomatic shoulder was defined when the score was 10 or higher. An activity questionnaire was administered to evaluate the subjects' self-reported participation in overhead-sports activities; the duration and frequency per week were assessed.

All patients were examined by a specialized shoulder surgeon who was blinded to the magnetic resonance imaging results.

### Radiographic analysis

Oblique coronal, oblique sagittal, and axial planes of the shoulders were analyzed on a 1.0-T Gyroscan ACS-NT-T10-Intra scanner<sup>a</sup> by 2 blinded and fellowship-trained musculoskeletal radiologists.

### Statistical methods

Data were evaluated using standard statistical software. The empirical distribution of continuous variables and scores was described by mean and SD and that of categorical variables by absolute and relative frequencies (count and percentage). Possible differences in continuous data between patients with and without an RCT were evaluated using the *t* test. To test differences between categorical variables, the chi-square test was performed. The relative risk of suffering from RCT was estimated between patients involved in overhead sports and those not involved in overhead

#### List of abbreviations:

**BMI** body mass index  
**RCT** rotator cuff tear  
**SCI** spinal cord injury

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