

## ORIGINAL ARTICLE

# Ultrasonographic findings in shoulders of able-bodied, paraplegic and tetraplegic subjects

J Kivimäki and E Ahoniemi

*Käpylä Rehabilitation Centre, Helsinki, Finland*

**Study design:** Cross-sectional.

**Objectives:** To evaluate the association between spinal cord injury (SCI) and ultrasonographic findings in shoulders.

**Setting:** Randomly selected patients of Käpylä Rehabilitation Centre and able-bodied citizens of Helsinki, Finland.

**Methods:** Ultrasonography of the shoulder was performed on able-bodied, tetraplegic and paraplegic subjects. Subjects with SCI were selected from patients of Käpylä Rehabilitation Centre, who were injured more than 3 months before the examination.

**Results:** Findings of the glenohumeral joint differed most clearly between the groups. Significant association between SCI level and oedema of the glenohumeral joint was noted in multiple regression analysis, where other background factors were also considered.

**Conclusion:** Paraplegic and tetraplegic subjects are prone to glenohumeral changes that can be verified with ultrasonography.

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**Keywords:** ultrasonography; shoulder; spinal cord injury

## Introduction

The association between spinal cord injury (SCI) and complaints in the upper extremities has been studied, with 69–76% of SCI subjects reporting pain in the upper extremities, most often around the shoulders.<sup>1–3</sup> Shoulder complaints gradually increase with time after injury.<sup>4,5</sup>

Persons with SCI typically place greater strain on the shoulder structures because they use their upper extremities in their daily activities of moving from one level to another and propelling a wheelchair. On the other hand, persons with severe high SCI have no muscle support or sensation around their shoulders and for this reason may be prone to injuries. Shoulder pain has been noted to be related to muscle imbalance, with comparative weakness of humeral head rotators and adductors.<sup>6,7</sup> This muscle imbalance may also explain why subjects with tetraplegia more often have shoulder pain than subjects with paraplegia.<sup>8–10</sup>

Shoulder imaging studies of subjects with SCI have been performed with rather small and selected groups. Arthrography of painful shoulders has revealed rotator cuff tears in 17% of subjects with tetraplegia and in 48% of subjects with

paraplegia.<sup>11,12</sup> In magnetic resonance imaging, the frequency of rotator cuff tears has varied from 4 to 57% in individuals with paraplegia.<sup>13,14</sup> Plain radiographs have frequently shown osteolysis in the distal clavicle and aseptic necrosis of the humeral head in the shoulders of paraplegic individuals.<sup>13</sup>

## Methods

Ultrasonography was performed on altogether 223 individuals; 150 men and 73 women, aged 18–65 years. A specialist in physical medicine and rehabilitation experienced in shoulder ultrasonography (JK) conducted the examinations. The examiner was not informed about the duration, level or completeness of any SCI.

In addition to 120 SCI patients (54 paraplegic, 66 tetraplegic), 103 subjects without SCI were randomly selected from individuals who had not experienced trauma to the shoulders and had no shoulder symptoms. SCI patient had been injured more than 3 months before the examination and had had no trauma to the shoulders.

Ultrasonography was performed in a standardised manner with an Aloka SSD 900 and using a 7.5 MHz transducer. During the examination, subjects were made to sit straight. The acromioclavicular joint was examined with the transducer directed caudally. The distance between the margins of the clavicle and the acromion, the height from the joint

Correspondence: Dr J Kivimäki, Käpylä Rehabilitation Centre, Nordenskiöldinkatu 18 B, Talkootie 13 B, Helsinki 00660, Finland.  
E-mail: jorma.kivimaki@elisanet.fi  
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space to the joint capsule and the greatest height of the osteophytes were recorded.

The supraspinatus tendon was examined longitudinally along the mid-axillary line, and its thickness at the border of the acromial arch was measured. Moreover, changes in the insertion of the supraspinatus tendon were evaluated.

The bicipitis longus tendon and the tendon sheath were evaluated with the transducer kept horizontally at the level of the proximal end of the bicipital sulcus. The anteroposterior dimension of the tendon sheath was measured.

The posterior glenohumeral joint space was evaluated just below the scapular spine. Irregularity of the joint margins and effusion of the joint were recorded. Student's *t*-test for continuous variables and  $\chi^2$ -test for discrete variables were used in statistical analysis of differences in ultrasonographic findings between SCI groups. In addition, in the second phase, the effects of age, gender, duration of SCI, American Spinal Injury Association (ASIA)<sup>15</sup> classification and use of assistive devices on ultrasonographic findings of the glenohumeral joint were tested with multiple regression analysis.

Shoulder pain of SCI patients was evaluated with performance-corrected Wheelchair User's Shoulder Pain Index (PC-WUSPI).<sup>10</sup>

**Table 1** Background characteristics of study groups

	Able-bodied (n = 103)	Paraplegic (n = 54)	Tetraplegic (n = 66)
Age (years), mean (s.d.)	41.3 (11.7)	47.0 (13.1)	45.0 (14.8)
Gender (%) male	53	76	83
Years from SCI, mean (s.d.)		8.9 (12.0)	6.7 (8.6)
<i>ASIA classification (%)</i>			
A		15	18
B		22	23
C		19	24
D		44	35
<i>Assistive device (%)</i>			
Sticks or rollator		7	10
Manual wheelchair		93	73
Electronic wheelchair		0	17

Abbreviation: SCI, spinal cord injury; s.d., standard deviation.

**Table 2** Supraspinatus tendon findings of study groups

	Able-bodied (n = 103)	Paraplegic (n = 54)	Tetraplegic (n = 66)	Significance
<i>Thickness (mm), mean (s.d.)</i>				
Right	7.7 (0.9)	7.9 (1.1)	7.5 (1.6)	NS
Left	7.6 (1.0)	7.7 (1.1)	7.3 (1.3)	NS
<i>Tendon calcifications (%)</i>				
Right	2	6	3	NS
Left	7	11	5	NS
<i>Irregularity of insertion</i>				
Right	8	15	14	NS
Left	7	22	12	<i>P</i> < 0.05

Abbreviation: NS, nonsignificant.

## Results

Background characteristics of the three subject groups are presented in Table 1. The majority of SCI patients had a partial lesion and used a wheelchair as an assistive device.

### *Ultrasonographic findings*

*Acromioclavicular joint.* Osteophytes were noted in the shoulders of 14% of able-bodied subjects, 22% of paraplegic subjects and 26% of tetraplegic subjects (*P* < 0.05). The mean (s.d.) acromioclavicular joint space was 4.0 mm (1.2 mm) among able-bodied subjects and 3.7 mm (1.3 mm) among SCI patients (NS). The mean height of the acromioclavicular joint capsule was 3.5 mm (0.8 mm) in all groups.

*Supraspinatus tendon.* No differences were present in the thickness of the supraspinatus tendon between groups, but irregularities and calcifications of the tendon and its insertion were slightly more common in SCI subjects (Table 2).

*Tendon sheath of bicipitis longus.* The mean thickness (s.d.) of the bicipital tendon sheath was 4.0 mm (0.5 mm) among able-bodied subjects and 4.5 mm (1.4 mm) among subjects with SCI (*P* < 0.01).

*Glenohumeral joint space.* Irregularity around the dorsal glenohumeral joint space and especially effusion under the joint capsule were noted more often in individuals with SCI than in their able-bodied counterparts (Table 3).

Associations that remained significant when all background variables were included in the model and effusion or right and left glenohumeral joint was used as a dependent variable and are presented in Table 4.

Effusion was noted in 6% of shoulders of subjects who used no assistive device or only used sticks or a rollator. In subjects using a manual wheelchair and in those using an electric wheelchair, the corresponding figures were 27 and 25% (*P* < 0.01). Frequency of shoulders with effusion gradually increased with age and it was noted in about half of the shoulders in oldest age groups.

Shoulder pain was related to glenohumeral effusion in subjects with paraplegia (Table 5).

**Table 3** Dorsal glenohumeral joint space findings of study groups

	Able-bodied (n = 103)	Paraplegic (n = 54)	Tetraplegic (n = 66)	Significance
<i>Irregularity of joint margins</i>				
Right	2	7	8	NS
Left	0	9	8	$P < 0.01$
<i>Effusion under joint capsule</i>				
Right	4	30	27	$P < 0.001$
Left	9	33	17	$P < 0.001$

Abbreviation: NS, nonsignificant.

**Table 4** Multiple regression analysis. Associations between background factors and glenohumeral effusion

	Estimate	Standard error	Significance
<i>Right shoulder</i>			
Assistive Device	0.106	0.022	$P < 0.001$
Age	0.006	0.002	$P < 0.01$
<i>Left shoulder</i>			
Assistive device	0.054	0.023	$P < 0.05$
Age	0.007	0.002	$P < 0.001$

**Table 5** Mean (s.d.) of PC-WUSPI according to SCI and effusion of glenohumeral joint

	PC-WUSPI score			Significance
	n	Mean	s.d.	
<i>Paraplegic</i>				
No effusion in glenohumeral joint	61	9.7	2.6	$P < 0.01$
Effusion in glenohumeral joint	31	20.0	6.8	
<i>Tetraplegic</i>				
No effusion in glenohumeral joint	100	13.8	2.8	NS
Effusion in glenohumeral joint	28	11.8	5.4	

Abbreviations: NS, nonsignificant; SCI, spinal cord injury.

## Discussion

Subjects in this study were randomly selected, and thus, age and gender distribution in groups were different. We consider the subjects with SCI examined here to represent well all individuals with this lesion in Finland.

The size of our SCI subject pool is larger than in many earlier imaging studies. In contrast to previous studies, we noted very small differences in changes of the supraspinatus tendon between subjects with and without SCI.

Changes in the dorsal glenohumeral joint space were significantly more frequent among SCI subjects than among able-bodied controls. This finding strongly suggests that subjects with SCI are prone to effusion in the glenohumeral joint. This effusion was obviously also reflected in the thickening of the bicipitis longus tendon sheath.

In multiple regression analysis, age of the subjects was strongly related to effusion in the glenohumeral joint space,

indicating a degenerative process of the glenohumeral joint. Use of either manual or electric wheelchair increased the risk for joint effusion. This finding suggests that effusion may be caused either by overload and repetitive minor trauma (paraplegics) or by diminished muscle protection around shoulder (tetraplegics).

Pain was related to glenohumeral effusion only in subjects with paraplegia possibly because they had better sensation around the shoulders. In contrary with previous studies, shoulder pain was not more frequent among tetraplegics than among paraplegics.

In conclusion, wear and tear changes of the glenohumeral joint appear to be frequent in subjects with SCI. When patients complain of a painful shoulder, evaluation of the glenohumeral joint spaces should be thorough.<sup>16</sup>

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