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Original Article

Shoulder pain and its consequences in paraplegic spinal cord-injured, wheelchair users

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Study design: Cross-sectional.
Objectives: To describe the consequences of shoulder pain on activity and participation in spinal cord-injured paraplegic wheelchair users. To describe the prevalence and type of shoulder pain.
Setting: Two spinal cord injury (SCI) centres in Sweden.
Methods: All subjects with paraplegia due to an SCI of more than 1 year living in the counties of Uppsala and Linköping, Sweden were contacted by mail and asked to fill in a questionnaire (89 subjects). Those of the responding 56 subjects with current shoulder pain were asked to participate in further examination and interviews. A physiotherapist examined 13 subjects with shoulder pain in order to describe type and site of impairment. To describe consequences of shoulder pain on activity and participation, the Constant Murley Scale (CMS), the Wheelchair Users Shoulder Pain Index (WUSPI) the Klein & Bell adl-index and the Canadian Occupational Performance Measure (COPM) were used.
Results: Out of all respondents, 21 had shoulder pain (37.5%). Data from 13 of those subjects were used in the description of type and consequences of shoulder pain. Findings of muscular atrophy, pain, impingement and tendinits were described. We found no difference in ADL-performance with, respectively without, shoulder pain ($P = 0.08$) using the Klein & Bell adl-index. No correlation was found between the various descriptions of impairment, activity limitations and participation restriction ($P > 0.08$). All together 52 problems with occupational performance due to shoulder pain were identified using the COPM. Of these, 54% were related to self-care activities.
Conclusion: The consequences of shoulder pain in paraplegic wheelchair users are mostly related to wheelchair activities. Since the wheelchair use itself presumably cause shoulder problems, this will become a vicious circle. More research is needed in order to reduce shoulder problems in wheelchair users.
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Keywords: shoulder pain; activity; participation

Introduction

Independence in occupational performance is a major goal in rehabilitation of the client with paraplegia due to a spinal cord injury (SCI). Whereas the ability to move and transfer is most central in the independence process and necessary to compensate for, the manual wheelchair becomes an important assistive device. However, the wheelchair user with paraplegia due to SCI puts an intense load upon the muscles and joints of the upper trunk and extremities during wheelchair propulsion, and in almost every other daily activity such as transfer, driving and household activities. Due to this potential intense load in the upper extremities, musculoskeletal pain is a common complication in the spinal cord-injured paraplegic wheelchair user. The impact of pain is sometimes described as worse than the loss of function itself, for example, on working ability.[1]

Wheelchair propulsion as well as transfers are supposed to cause and increase upper extremity pain, such as shoulder pain in active wheelchair users.[2] Consequently, shoulder pain has been found to have a high prevalence in the spinal cord-injured population.[2–7] While the primary injury itself limits individual

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independence, any further functional limitation due to secondary complications, could cause a marked decrease or even total loss in remaining functional independence.[8,9] The main aim of this study is to describe the consequences of shoulder pain on activity and participation in spinal cord-injured paraplegic wheelchair users. We have also discussed the prevalence and types of shoulder pain.

Materials and methods

Definitions

The sites of motion within the *shoulder girdle* are; the sternoclavicular joint, the acromioclavicular joint, glenohumeral joint and the scapulothoracic interface (Figure 1). There are also several other structures around the shoulder complex that are involved in movements of the upper extremity and which can be the site of shoulder pain.[10] The most mobile joint is the junction of the humerus and scapula. Shoulder mobility is classified by three patterns of motion: elevation, internal/external rotation and horizontal flexion and extension. In any function of placing the hand in a meaningful position for manual occupations, all main structures of the shoulder complex are involved.

The terms *activity* and *occupation* are both used in relation to outcomes in this study. By activity–outcome, we mean the performance of individual activities or tasks, predefined and usually included in ADL-assessment tools such as the Klein & Bell adl-index.[11] By occupational outcome, we use the definition of occupation, developed by the Canadian Association of Occupational Therapists (CAOT),[12] *the performance of those groups of activities and tasks given value or meaning by individuals and culture* and which consequently has to be individually defined such as in the Canadian Occupational Performance Measure (COPM).[13]

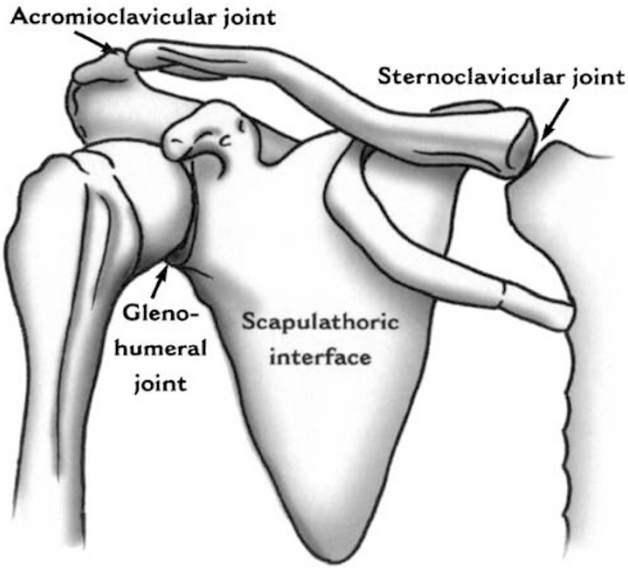

Figure 1 The shoulder girdle

Data collection and study population

In order to describe the consequences of shoulder pain, we have referred to the structure of classification in the ICIDH-2.[14] The type and site of shoulder impairment is described as a body function. The consequences of shoulder pain are described at an individual (activity) and society (participation) level, considering contextual factors of the individual. In this study, we have used different assessment tools in order to be able to describe type and consequences of shoulder pain, with reference to the ICIDH-2.

All subjects with paraplegia due to an SCI of more than 1 year before this study, known to the University Hospitals of Uppsala as well as Linköping and living in the counties of Uppsala or Linköping, were contacted by mail. A package, including a cover letter, consent form, questionnaire and an addressed envelope, was send to 89 subjects. The questionnaire contained items about, for example, amount of years as wheelchair user, wheelchair transfers, primary occupation, sport activities, driving, prevalence of shoulder pain, back pain and hand/elbow pain. The questionnaire also contained an evaluation-form concerning wheelchair ergonomics where all subjects were asked to evaluate a number of functionality aspects of their wheelchair on a 7-point scale from 1 = very bad to 7 = very good. In all, 56 subjects responded (63%). All subjects admitting having had shoulder pain during the last month were asked to participate in a physical examination and a complementing interview.

Physical examination including Constant–Murley score (CMS)

An individual examination in order to describe the type and location of the shoulder pain was performed by one physiotherapist. A total of 14 different and well-defined sites, such as the sternoclavicular joint, acromion, acromioclavicular joint, processus coracoideus, tuberculum minus and others, were palpated. Furthermore, conventional signs and tests were used, such as drop arm sign, the Neers sign, Hawkins sign and the painful arch, in order to define occurrence of instability and impingement. Three tendons were palpated in order to describe signs of tendinitis; M. supraspinatus, M. infraspinatus and M. biceps. A specific form, which included the Constant–Murley Score (CMS),[15] was used to document the findings.

The basis of the CMS is a 100-point score composed of a number of individual parameters. The included so-called subjective parameters define the degree of pain the patient experiences and the ability to perform normal daily living tasks. The degree of pain the patient experiences is defined from 0 to 15 points and the ability to perform the normal tasks of daily activity from 0 to 20 points. After the subjective data collection is carried out, the objective testing of active motion range from 0 to 40 points and shoulder power from 0 to 25 points is assessed.

Interview and questionnaires
In order to describe pain in relation to activity performance as well as the consequences of shoulder pain on activity and occupational performance, three different assessment tools were used.

The Wheelchair Users Shoulder Pain Index (WUSPI)
Curtis *et al*[6] described the development of a new index (WUSPI) to detect the effect of shoulder pain on daily activity performance. The WUSPI is a 15-item self-report instrument measuring shoulder pain during daily living. (1) Transfer from bed to wheelchair, (2) transfer from wheelchair to car, (3) transfer from wheelchair to tub or shower, (4) loading the wheelchair into a car, (5) pushing the wheelchair for 10 min or more, (6) pushing up ramps or inclines outdoors, (7) lifting objects down from an overhead shelf, (8) putting on pants, (9) putting on a t-shirt or pullover, (10) putting on a button down shirt, (11) washing ones back, (12) usual daily activities at work or school, (13) driving, (14) perform household chores and (15) sleeping are the included items. The instrument is based upon visual analogue scales, with a minimum score of zero and a maximum score of 10 cm for each of the 15 items. The anchor points are 'no pain' and 'worst pain ever experienced'. The total score is calculated by taking the sum of all the 15-item scores with a possible range of 0–150 cm. The average WUSPI-score is calculated by dividing the total score by the number of completed items. The WUSPI has shown high reliability and internal consistency.[16]

The Klein & Bell adl-index
The instrument was initially designed to measure ADL independence in children and adults. The scale has 170 items in six domains: dressing, mobility, elimination, bathing and hygiene, eating and emergency communication. Each subtask is weighted from 1 to 3 related to; its importance to health, its difficulty for a nondisabled person, the time required to perform it, and, the associated burden of care giving. The total score can range from 0 to 313. Evidence of predictive validity has been obtained from correlation's between Klein & Bell scores and the hours per week of attendant care ($r=-0.86$).[17] All subjects with shoulder pain were interviewed by an occupational therapist using the Klein & Bell index.[11] The subjects were asked to identify their activity performance both with and without shoulder pain. Consequently, two copies of the Klein & Bell-index were used for each client.

The Canadian Occupational Performance Measure (COPM)
This instrument is an individualised measure in the form of a semistructured interview designed to measure a client's self-perception of occupational performance.[13] The administration of the COPM was performed stepwise: (1) the subject identified occupational performance problems related to his/her shoulder pain, (2) the subject rated the level of importance of each problem on a 10-point scale with the anchor points; 1 = 'not important at all' to 10 = 'extremely important'. (3) Those problems considered of most importance to the subject were scored by the subject on a 10-point performance scale with anchor points; 1 = 'not able to do it at all' and 10 = 'able to do it extremely well' and a satisfaction scale with anchor points 1 = 'not satisfied at all' and 10 = 'extremely satisfied'. Hence, COPM describes two dimensions on an individual and society level; (a) the ability to perform a desired occupation, which by definition will be influenced by personal and environmental factors and (b) the satisfaction one experiences with that performance.

Statistics

Statistical analyses were made using the Statistica 5.5'99 edition (Statsoft 2300 East 14th street Tulsa, OK, USA). Data from the initial survey were analysed using descriptive and comparative statistics. Comparative statistical analysis was performed using Student's *t*-test, Mann–Whitney *U*-test, χ^2-test and Fisher's exact test. Level of significance was set at $P \leqslant 0.05$. Correlation analyses were performed using the Spearman's rank correlation test.

Results

The mean age of all respondents ($n=56$) was 49 ± 18 years. There were 12 (21%) women and 44 men. The mean time as a wheelchair user was 13.9 ± 10.8 years. There was a difference between estimated seating versus mobility ergonomic conditions of the wheelchairs used in the responding group. Seating ergonomics was estimated significantly poorer than mobility ergonomics ($P=0.005$).

Subjects who reported shoulder pain did not differ from those subjects having no shoulder pain concerning age, gender, years of wheelchair use, weekly hours of work, amount of wheelchair transfers per day, participation in sport activities or time spent in wheelchair/day (Table 1). The prevalence of back pain was 71% in all the subjects. The prevalence of back pain was not more common in subjects with shoulder pain than in subjects without shoulder pain ($P=0.35$). However, the prevalence of elbow and hand pain was more common in those subjects having shoulder pain (32%), than in subjects without shoulder pain (20%), $P=0.0001$.

Out of all respondents, 21 had had shoulder pain during the last month (prevalence = 37.5%). In total, 24% of those subjects having current shoulder pain had experienced shoulder pain before their SCI in relation to 9% of those with no current shoulder pain. Out of the 21, 15 subjects (71%) with shoulder pain agreed to further examination. Two individuals were excluded from the examined group, while one subject had additional diseases and could not be examined properly and one subject had no shoulder pain at the time for

Table 1 Descriptive data of subjects

	With shoulder pain (N=21)	*Without shoulder pain (N=35)*	*Statistics (P-value)*
Age (years)	52.4±17.0	46.8±17.4	NS (0.1)
Gender (% women)	12.5%	9%	NS (0.1)
Time since injury (years)	16.2±11.2	12.5±10.5	NS (0.1)
Amount of transfer/day	17.2±2.1	15.4±8.9	NS (0.3)
Time in wheelchair/day (h)	11.8±4.0	11.3±3.5	NS (0.3)
Hours at work/week	23.8±9.3	26.9±8.9	NS (0.2)
Participation in sport activities	6/21 (29%)	16/35 (46%)	NS (0.3)

No significant difference was found between groups on any of the descriptive variables

examination. Thus, the final examined subject group consisted of 13 individuals with current shoulder pain.

Findings

CMS (0 – 100) Six individuals complained of pain from their right shoulder, three from their left and four from both the shoulders. The mean score for CMS on painful right shoulder ($n=10$) was 57±10 and on left shoulder ($n=7$) 47±18. In the studied group, 11 subjects (85%) had a CMS of <70, which is considered illustrate a significant shoulder impairment.

Clinical signs Clinically obvious muscular atrophy of the painful right shoulder area was found in five out of 10 subjects (50%). Muscular atrophy in the painful left shoulder was found in two out of seven subjects (29%). Five individuals had reduced range of motion (ROM) in their painful right shoulder girdle and three individuals had reduced ROM in their painful left shoulder girdle.

Pain and/or swelling Eight out of 10 individuals reacted with pain at palpation of two or more sites in their painful right shoulder girdle (80%). The most common sites for pain were processus coracoideus and tuberculum majus. Five out of seven individuals (71%) reacted with pain at palpation in their painful left shoulder girdle, two individuals had no pain at palpation.

Impingement Seven out of 10 individuals had signs of impingement in their painful right shoulder (70%). Two out of seven individuals had signs of impingement in their painful left shoulder (29%). Two individuals had no signs of impingement.

Tendinitis Four individuals out of 10 had symptoms of tendinitis in their painful right shoulder, all with symptoms from the tendons of M. supraspinatus and M. infraspinatus. Three individual out of seven had symptoms of tendinitis from their painful left shoulder.

The Klein & Bell adl-index No significant difference was found in adl-performance, with respect to ability to perform the defined activities, with shoulder pain (237±90) and without shoulder pain (252±83) as reported by the subjects using two sets of the Klein & Bell adl-index ($P=0.08$).

WUSPI The highest pain intensities were found for the activities; 'load wheelchair into a car' ($M=6.7\pm2.7$ cm), followed by 'pushing up ramps or inclines outdoor' ($M=5.7\pm2.8$ cm) and 'usual daily activities at work or school' ($M=5.5\pm3.2$ cm) (Figure 2). Mean value for all subjects according to average WUSPI score was 4.1±2.6 cm, with a range from 0.4 to 6.6 cm.

COPM The 13 individuals with current shoulder pain identified all together 52 problems with occupational performance. Of these identified problems, 28 were related to self-care activities (54%) such as propelling the wheelchair outdoors, transfers and driving, 12 problems were related to productivity (23%) such as

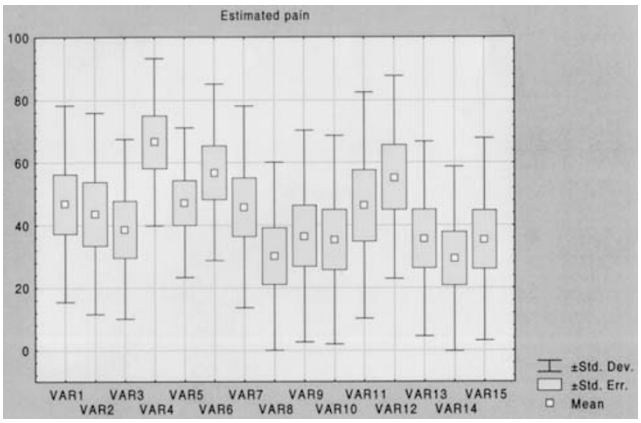

Figure 2 Estimated pain during activity performance in the 15 predefined activities (WUSPI). The mean value, standard deviation and standard error in each activity are given. VAR1, transferring from bed to a wheelchair ($n=11$); VAR2, transferring from a wheelchair to a car ($n=11$); VAR3, transferring from a wheelchair to a tub ($n=11$); VAR4, loading your wheelchair into a car ($n=11$); VAR5, pushing your chair for 10 min ($n=12$); VAR6, pushing up ramps or inclines outdoors ($n=12$); VAR7, lifing objects down from overload shelf ($n=13$); VAR8, putting on pants ($n=12$); VAR9, putting on a t-shirt or pullover ($n=13$); VAR10, putting on a button down shirt ($n=13$); VAR11, washing your back ($n=11$); VAR12, usual daily activities ($n=11$); VAR13, driving ($n=12$); VAR14, performing household chores ($n=13$); VAR15, sleeping ($n=13$)

cleaning, cooking and working and another 12 problems related to leisure activities (23%) such as fishing, gardening, training and social relations. The most common identified problems were 'wheelchair transfer in and out of car' (62%) and 'wheelchair propulsion' (46%). The estimated median value of performance in identified occupations was 4.2 with a range from 3 to 8.5 on the 10-point scale. The estimated median value of satisfaction with performance was 3.2 with a range from 1 to 9 on the 10-point scale.

Correlation analysis A correlation analysis was performed including data from the different assessment tools. The correlation analysis was performed using the Spearman rank correlation coefficient. The CMS and WUSPI had a correlation coefficient of $R_s = -0.52$ (NS). The WUSPI and Klein & Bell adl-status had a correlation coefficient of $R_s = 0.10$ (NS) and the Klein & Bell adl-status and COPM (performance) had a correlation coefficient of $R_s = 0.07$ (NS).

Discussion

The results of this study show a prevalence of shoulder pain in 37.5% of individuals answering the postal survey. Other studies have reported prevalence's of approximately 50 – 70%.[3,5,7] The incidence of nontraumatic shoulder pain has been described by Silverskjold and Waters[8] during the first 18 months after SCI. They found an incidence of 10% among paraplegics, and that the level of functional disability was mild. In the first 6 months, the incidence was 35% in paraplegics and there was no correlation between the presence of pain and the completeness of SCI. The cause of acute or chronic shoulder pain in wheelchair users has been discussed, in most cases in wheelchair athletes. Burnham *et al*[18] refer to the muscle imbalance as a possible factor in the development and perpetuation of rotator cuff impingement syndrome in wheelchair athletes. Apple[19] relates to two major types of sports-related injuries; acute microtraumatic injuries, which are the result of a one-time inciting event, or chronic microtraumatic injuries, which occur over time and are often secondary to repetitive motions. Injuries related to overuse or overload account for up to 50 per cent of all sports-related injuries in individuals with SCI.[18] Nichols *et al*[3] concluded that the spinal cord-injured population have an expectation of suffering from neck and/or arm pain far greater than their age would explain. Lal[20] reported radiological evidence of degenerative changes in the shoulders of spinal cord injured patients in 72% of a studied group, but only 11% complained of shoulder pain. Lal[20] also found that there is a correlation between development of degenerative changes in the shoulder and high level of wheelchair use, higher age and female gender. Our result does not confirm these findings.

Sitting posture in relation to shoulder pain in wheelchair users is not previously discussed. Since many spinal cord-injured wheelchair users, in order to be stable in wheelchair propulsion and other activities, they tend to sit in a kyphotic posture where the scapula changes its vertical alignment. The scapula will rotate in the sagittal plane forward and downward, depressing the acromial process and changing the facing of the glenoid fossa. When there has been a painful shoulder with a painful arc indicating entrapment of the greater tuberosity on the acromial process and the coracoacromial ligament, the contributory posture of the subject must be evaluated.[10] The seating posture must be addressed for ultimate success in pain relief for wheelchair users.

In this study, we have described the consequences of shoulder pain on body function, activity and participation. No correlation was found when analysing data from those different components. This might be explained by the fact that most spinal cord-injured paraplegics have to manage their personal daily activities regardless of shoulder pain. They have to propel their wheelchair, do transfers, dress and eat even if they have pain. The assessment tools used in this study focuses on different aspects. Assessment tools such as the WUSPI defines the pain experienced during predefined activities or tasks without reflecting the actual grade of activity performance. Traditional ADL-instruments such as the Klein & Bell adl-index consist of fundamental activities, which most individuals perform even with shoulder pain. The COPM reflects those problems that are of importance to the individual and that is considered problematic. The different basis of the assessment tools used in this study might explain the absence of correlation between different results.

In a studied group, Gellman *et al*[5] reported that 30% of spinal cord-injured paraplegics had complaints of shoulder pain during different transfer activities. Subbarao *et al*[2] reported from a survey of 451 individuals with SCI that the incidence of wrist pain and/or shoulder pain was 72.7%, that subjects reported a moderate to severe degree of pain upon initiation of activities such as propelling wheelchairs (54%) and transferring to and from wheelchairs (59%). Participation in wheelchair sports also resulted in pain. In a study of Bayley *et al*,[4] 33 per cent in a group of individuals with complete paraplegia had complaints about shoulder pain during transfer activities. Curtis *et al*[21] compared the intensity of shoulder pain experienced during daily activities by individuals with paraplegia and tetraplegia. The variables with the highest mean values, estimated by the paraplegics were 'pushing wheelchair > 10 min' followed by 'pushing wheelchair up ramp/inclines'. In our study the highest estimated pain were in 'loading wheelchair into car' followed by 'pushing up ramp/inclines'. Even if shoulder pain may not initially limit the ability to perform different activities independently, it may have functional costs such as rapid fatigue, loss of endurance, decreased speed or efficiency of movement, low tolerance for prolonged work or leisure activity.[21] In our study, subjects with shoulder pain identified most occupational problems in the area of self-care activities, where mobility is included,

followed by the area of productivity. The possible causes and consequences of shoulder pain need to be further described, analysed and discussed at different levels and together with wheelchair use and wheelchair ergonomics.

Conclusion

The prevalence of shoulder pain in the studied group was quite low, compared to other studies. For those individuals who are affected, the consequences on activity performance and participation could be very considerable. When describing consequences of shoulder pain on activity performance, we found that most defined problems were related to wheelchair use, for example, loading wheelchair into car, pushing up ramps or inclines outdoors and transfer activities, consequently, it is important to use assessment tools containing these kinds of activities. Whereas the assessments of pain-intensity, shoulder function and ability to perform activity and participate in society did not correlate in this study, it is important to stimulate further research to describe the consequences and effects of intervention at different levels. This study has given us useful tools for everyday practice with the rehabilitation of clients with SCI.

Acknowledgements

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