Shoulder pain in tetraplegia

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Abstract

The effects of shoulder pain and the outcomes of treatments for shoulder pain are of great consequence to the person with tetraplegia, as the shoulder is one of the few functioning regions following spinal cord injury. Shoulder pain is common in tetraplegia. Following cervical spinal cord injury many people experience severe shoulder pain and stiffness, which although frequently seen, is poorly understood. People with long-standing cervical spinal cord injury may experience shoulder pain due to a wide range of pathologies that may relate to overuse or overload of the shoulder.

Clinical examination and investigation of the tetraplegic shoulder are similar to evaluation and investigation of the shoulder in ambulant patients. It is also important to consider other factors in the assessment of the tetraplegic shoulder, including wheelchair type, ergonomics and environment. Individual factors include transferring technique, patterns of use and posture, patterns of weakness and stiffness. Treatments commonly include physiotherapy, modifications in environmental factors, sometimes injections and occasionally surgery. If surgery is undertaken, it is important to plan for a period of increased dependence during the recovery stage and optimal to have the support of a spinal injuries rehabilitation unit.

Keywords physical examination; rehabilitation; shoulder pain; spinal cord injuries

Introduction

In the absence of lower limb function and in the context of tetraplegic upper limb dysfunction, the shoulder is of great importance. There are significant functional demands on the tetraplegic shoulder and those with shoulder pain are further disabled. The medical aphorism “do no further harm” certainly applies when treating the person with tetraplegia and shoulder pain. Any small deterioration after well-intentioned but unsuccessful treatment may result in significant functional losses. What do we know about the shoulder and shoulder pain in tetraplegia? This review of the literature and our unit’s experiences, attempts to answer some questions on this topic.

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Shoulder pain is common in tetraplegia

There are a number of studies reporting that shoulder pain in spinal cord injury (SCI) is common, with a prevalence of 30–80%.[1–4] The wide range in the reported prevalence may be due, in part, to different methods and time frames for evaluation. However all studies conclude that shoulder pain is common in tetraplegia and most studies report it is more common in those with tetraplegia than paraplegia.

Shoulder pain in acute spinal cord injury

People with acute SCI have a high prevalence of shoulder pain in the first year after injury, with studies reporting 75–85% having pain at some time in the acute period.[5,6] Salisbury et al.[5] reviewed 41 acute tetraplegic patients during their initial admission to the Spinal Injuries Unit and found that 85% had shoulder pain during their admission and 50% still had pain on discharge. They reported that pain was more common with higher neurological level and when there had been a shorter period of bed rest in the management of the spinal fracture. Shoulder pain during this acute post-SCI stage was associated with a decreased range of motion. Waring and Maynard[6] reviewed 52 patients admitted acutely with SCI and found that 75% had shoulder pain at some time during their admission and 60% had 2 weeks or more of shoulder pain.

Although significant shoulder pain and stiffness in acute SCI is frequently seen, the cause of this pain remains unknown. It is possible that centrally mediated neuropathic pain contributes. Soon after SCI, deafferentation is associated with Wallerian degeneration from the spinal cord into the cerebral cortex, with cortical reorganization. Functional MRI in animal studies suggest that this reorganization may begin within days of SCI.[7] Central neuropathic pain after SCI may occur at the level, above the level or below the level of the SCI. Above-level pain characteristics include mechanical allodynia and thermal hyperalgesia.

Carlton et al.[8] found, in an animal study of above-level pain, that there was a rostral spread of glial activation 35 days following SCI. They hypothesized that reactive glia in the uninjured cervical cord released substances that may drive chronic central neuropathic pain. In a review of the mechanisms of chronic central neuropathic pain after SCI, Hulsebosch et al.[9] discussed peripheral sensitization contributions to above-level pain, microglial activation in below-level pain and intracellular signalling mechanisms pathways in at-level pain. So it seems clear that central neuronal changes, both structural and biochemical, occur soon after SCI and that pain patterns exist around the level of SCI. It seems likely that these may contribute to the severe pain and sensitivity commonly seen in the shoulder in acute SCI.

Shoulder pain in chronic spinal cord injury

In the period more than one year following SCI, studies have reported the prevalence of shoulder pain to be 60%–70%.[10–12] Salisbury et al.[12] reviewed 27 patients 2–4 years after SCI and found a prevalence of 70%. In contrast to their findings after acute SCI, pain in the chronic phase was more common in those with lower neurological injuries (C6-T1). Dalyan et al.[11] surveyed patients more than one year following SCI. Of the 130 respondents, 62 were tetraplegics and 68 were paraplegics. The

shoulder was the most common site of upper limb pain, with 60% of respondents with tetraplegia reporting pain. Curtis et al.[10] reviewed 92 tetraplegic and 103 paraplegic patients who were manual wheelchair users, more than one year following SCI. Shoulder pain was present in 59% of tetraplegic patients and 42% of paraplegic patients. Pain was more intense in those with tetraplegia. Aggravating factors included incline wheelchair use and more than 10 min of continuous wheeling. The causes of shoulder pain in people with long-standing SCI are many and varied and will be discussed later in this review.

Shoulder pain is often significant in tetraplegia

The severity of shoulder pain in tetraplegia is often significant. Salisbury et al.[12] reported that 70% of those reporting shoulder pain felt this affected their quality of life. Dalyan et al.[11] found that 60% of tetraplegic patients reported their shoulder pain to be moderate or severe, with 80% of these patients reporting sleep disturbance and 28% reporting that shoulder pain limited their independence. Shoulder pain often interferes with transfers, incline or prolonged wheeling.

Learning points

- shoulder pain is common in tetraplegia
- severe shoulder pain and stiffness are common after acute SCI, even in the absence of structural injury to the shoulder
- shoulder pain in the tetraplegic patient is often significant and disabling, affecting independence and quality of life

Common features of the tetraplegic shoulder

People with tetraplegia have weakness and wasting of the muscles around the shoulder. The degree varies according to the neurological level and patterns of use. We examined a cohort of people with tetraplegia for strength of shoulder movements and EMG of shoulder muscles.[13] Shoulder adduction, extension then external rotation were the weakest movements. Absence of voluntary EMG was only seen in the *latissimus dorsi*, and only in patients with very high cervical neurological lesions.

Decreased range of motion is common in tetraplegic shoulders, especially in the first year following SCI, and often associated with pain. Eriks-Hoogland et al.[14] examined 199 subjects with acute SCI, of which 40% were tetraplegic. They reported that 70% of tetraplegic patients had limitations in range of motion, with flexion being the most affected. Risk factors for stiffness in their study included increased age, spasticity, delay in starting rehabilitation and shoulder pain. They defined limitation of range of motion as being 10% less than previously described "normal" values in the able-bodied populations. It should be noted, however, that there is a wide range of differences in shoulder movements in the general population.

Learning point

- some shoulder weakness is expected in the tetraplegic patient, but most muscles around the shoulder are innervated to some degree with the potential to be strengthened

Evaluation of the painful shoulder

Patient history

Important features of the clinical history include the time since SCI and the presence of specific injury to the shoulder before, at, or after SCI. The location, nature, severity of the pain should be noted. Exacerbating factors may include wheelchair use or transferring. Ascertain whether the patient has had previous treatments and take note of the outcomes of these treatments. The impact of shoulder pain on the patient's quality of life and independence are important to appreciate and measure. Use of objective measures such as the Wheelchair Users Shoulder Pain Index[15] (WUSPI) will allow for assessment of shoulder pain on functional tasks.

Examination

The type of wheelchair (manual or power) now used and previously used should be noted. Examine the patients' posture and chair set up. Patients may have a thoracic kyphosis with shoulder protraction. Examine the shoulder for tenderness. Assess muscle wasting (Figure 1). Look for myofascial trigger points in the deltoid, rhomboids and coracoid regions. Treatment directed to these trigger points may be helpful. Look for acromioclavicular (AC) joint tenderness and subacromial bursal tenderness.

Examine the active and passive range of shoulder motion. Look for restriction of external rotation. Is it due to spasticity e.g. pectoralis major, biceps or triceps spasticity, or is there a general "capsular" pattern of stiffness? Look for posterior capsular tightness in abduction and internal rotation (glenohumeral internal rotation deficit (GIRD)).

Examine the strength of the shoulder muscles and be aware of shoulder adduction and external rotation weakness. Shoulder protraction posture, posterior capsular tightness and adduction weakness may all contribute to subacromial impingement pain. Further special tests can be performed, looking for subacromial impingement, AC joint pain, labral tears and glenohumeral instability. These are the same special tests used to evaluate the shoulder in the able-bodied population. For subacromial impingement, we find Hawkins–Kennedy test, the painful arc and checking for glenohumeral internal rotation deficit (GIRD) useful. Lag signs may be

Figure 1 Observation of the shoulder from above to evaluate posture and muscle wasting.

useful in rotator cuff tears. AC joint tenderness and pain localized to the AC joint during cross body flexion are useful to assess whether the AC joint may be symptomatic. Apprehension and relocation tests are useful in glenohumeral instability. There are a number of labral tests, including O'Brien's test, and Speed's test for biceps pathology. None of these special tests are definitive in their diagnostic accuracy, but together with patient history and imaging investigations, can help with diagnosis.

Remember too, to be aware of pain referred from the cervical spine. Examine the rest of the upper limb. Is progressive weakness part of the presentation? If so, consider a spinal syrinx.

Investigations

Imaging is along the lines of shoulder imaging for the able-bodied population. We recommend plain radiographs and, often, ultrasound scans in the initial evaluation of the painful tetraplegic shoulder. These can screen for the presence or absence of new or old bone trauma, calcific tendinosis, heterotopic ossification, signs of rotator cuff disease or tearing and glenohumeral and AC joint arthrosis. MRI scans, sometimes with arthrography, may be indicated for more detailed evaluation of the rotator cuff, glenoid labrum, or to look for uncommon lesions such as paralabral cysts. Useful information regarding the reparability or otherwise of cuff tears may obtained from MRI. In chronic rotator cuff tears with severe muscle fatty degeneration and atrophy, surgical repair is unlikely to be successful (Figure 2). Paralabral cysts may cause suprascapular nerve compression with pain and weakness. In traumatic glenohumeral instability, CT scans are sometimes used to evaluate glenoid and humeral bone lesions.

Learning points

- clinical examination and imaging techniques are similar to the evaluation of the shoulder in able-bodied patients
- shoulder protraction, adduction weakness, external rotation weakness and GIRD are common findings and may contribute to impingement
- in chronic shoulder pain and tetraplegia, the effects of overuse may contribute to AC joint arthrosis, subacromial impingement from bursitis, rotator cuff tendinopathy and rotator cuff tears and glenohumeral joint arthrosis. Causes of pain may be multifactorial
- if progressive upper limb weakness is present, check for a spinal syrinx with cervical MRI scan

Treatment principles

Regardless of the diagnosis, there are some useful principles for the treatment of the painful tetraplegic shoulder. A period of relative rest with assisted transfers and a powered wheelchair may be indicated. Rehabilitation with physiotherapy should aim to improve posture, range of motion and inner range strength. Shoulder protraction posture predisposes to subacromial impingement and efforts should be made to improve shoulder retraction. Shoulder adduction is often weak. Stretching the pectoralis major and strengthening *latissimus dorsi* can help decrease impingement symptoms by providing humeral head depressor effect. Patterns of use, wheelchair set up and the role of activity modification, should be considered.

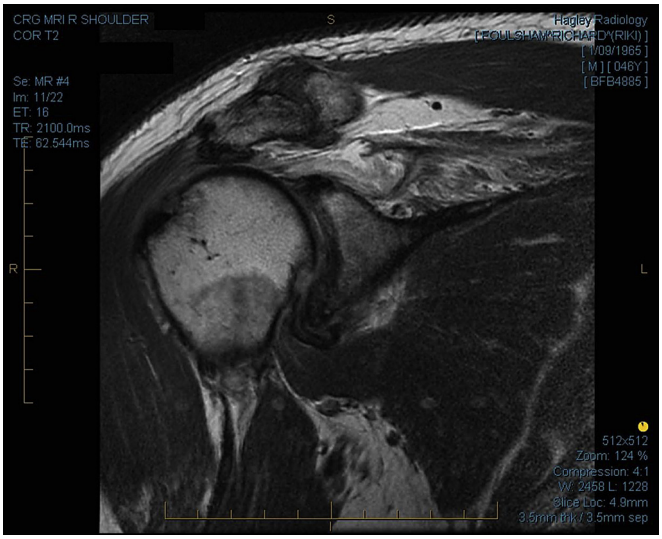

Figure 2 MRI of the shoulder demonstrating severe (Goutalier Grade 4) fatty degeneration of supraspinatus in a chronic irreparable rotator cuff tear.

Selective corticosteroid injections (subacromial, glenohumeral and AC joint) can be considered, but data on efficacy or safety are not available. Surgery may have a role. The decision to undertake surgery involves the patient, who must be advised of the recovery process, period of disability, support options and the outcomes and risks of surgery. In principle, arthroscopic techniques, preserving the important deltoid muscle, are preferable where possible. Surgery should be planned and performed in the setting of a specialized spinal unit for post-operative care, rehabilitation and support. Procedures may include arthroscopic acromioplasty, glenohumeral debridement, AC joint debridement and rotator cuff repairs. Figure 3 provides a perspective of the relative frequencies of injections, MRI scans and surgery in our unit for shoulder pain in tetraplegia.

Learning points

- consider wheelchair type (manual or power), wheelchair set up, environment and transfer technique in assessment and treatment options
- physiotherapy is often useful for stretching tight/spastic muscles and strengthening key shoulder muscles
- selective cortisone injections may be useful
- surgery, when undertaken, should be followed by appropriate support and rehabilitation, ideally in the context of a spinal unit

Specific diagnoses

Diagnoses related to SCI

Anticipate the likelihood of shoulder pain and stiffness without structural injury in acute SCI. Early rehabilitation with full shoulder range of movement for all acute SCI admissions is recommended. We have no data to determine the effectiveness of glenohumeral cortisone injections or other strategies.

Spasticity may cause painful problematic contractures, e.g. pectoralis major contracture. Consider Botulinum Toxin and tenotomy.

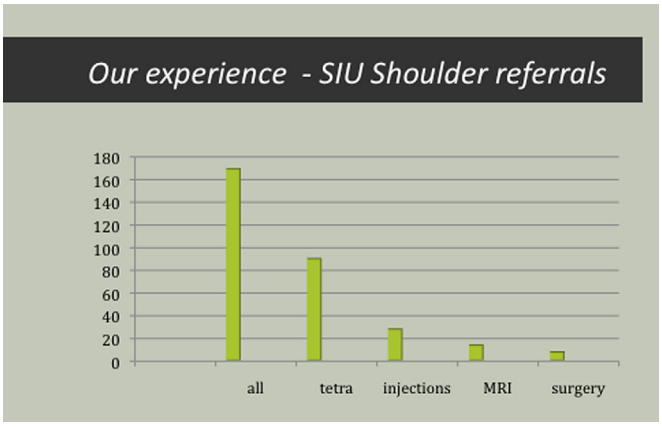

Figure 3 An audit of referrals for shoulder pain at the Burwood Spinal Injuries Unit indicating the frequency with which various interventions are used in relation to the total number of patients treated.

In high-level lesions, inferior subluxation of the shoulder from hypotonia may be painful. We have tried functional electrical stimulation with little success. Management of symptoms is attempted through analgesia and supportive positioning in the wheelchair and bed.

Painful winging of the scapular has been treated by scapulothoracic stabilization surgery in a small number of patients[16] but we have no experience of this in tetraplegic patients, in our unit. In a patient with progressive weakness, consider and investigate for a syrinx with a spinal MRI scan and refer to the neurosurgeons as required.

Learning point

- shoulder range of movement exercises are recommended for patients admitted with acute cervical SCI to decrease the frequency and severity of shoulder pain

Diagnoses in common with able-bodied population

Subacromial impingement (with or without rotator cuff tear), arthrosis of the AC joint or glenohumeral joint, and instability are examples of shoulder conditions commonly seen in able-bodied populations, and these may also be seen in tetraplegic patients. There is often a combination of factors contributing to shoulder pain in these patients. It is likely that chronic weight bearing demands and overuse of the tetraplegic shoulder may exceed the homeostatic tolerance of the shoulder. Myofascial pain, AC joint arthrosis, subacromial impingement, tendinopathy and chondral changes may occur. Contributing features may include protracted posture, capsular tightness, adduction and extension weakness. Although there is some evidence that the prevalence of rotator cuff tears is greater in paraplegia than the general population,[17] and although intuitively it would seem likely that persons with tetraplegia would have a high incidence of rotator cuff tears, we are unaware of any proof that this is the case.

Subacromial impingement: patients with subacromial impingement may have pain in the shoulder and deltoid region that is worse on attempted overhead movement and worse after periods of increased loading e.g. transfers or incline wheeling. Often night pain is a feature. Patients may have a protracted shoulder posture, tight posterior structures (GIRD) and shoulder adduction weakness. Patients may have a painful arc and positive Hawkins–Kennedy test. Arm elevation strength testing may provoke pain and be weak. On plain X-rays check for a subacromial spur and cystic changes in the greater tuberosity, which may be associated with chronic rotator cuff disease. If narrowing of the acromiohumeral interval on an AP X-ray (less than 7 mm) is present, then there is likely to be a chronic, large, retracted, irreparable rotator cuff tear. Ultrasound scan is used to determine whether a significant rotator cuff tear is present.

Subacromial impingement may occur with bursitis, tendinopathy/tendonitis, partial thickness rotator cuff tears, full thickness rotator cuff tears and calcific tendonitis. For impingement without full thickness rotator cuff tear initial treatments include physiotherapy, activity modification and subacromial cortisone injection. If symptoms are ongoing, arthroscopic acromioplasty may have a role. We are unaware of any published data on outcomes in this group of patients. In full thickness rotator cuff tears, there may be a role for surgery in patients with significant symptoms and a repairable tear. Data are not available to assess the relative long terms risks of conservative versus surgical treatments.

In theory, tears may progress in size and be harder to repair or less likely to heal. If symptoms are managed without surgery, we suggest interval review of symptoms and tear size with imaging within 12 months. We prefer arthroscopic repair of the rotator cuff, to preserve the important deltoid muscle, with 6 weeks of immobilization in a sling, followed by graded movement exercises. During this time patients use a power wheelchair before commencing pushing their manual wheelchair and then progress to transfers 3 months following surgery. We are unaware of published data on outcomes of rotator cuff repairs in tetraplegic patients.

Acromioclavicular joint pain: acromioclavicular joint pain may arise gradually or after a fall on the point of the shoulder. Pain and tenderness are usually well localized to the AC joint. Imaging findings of AC joint arthrosis are very common. Eriks-Hoogland et al.[18] used MRI to study the AC joints of 68 SCI patients, of which 28% were tetraplegic, and 105 able-bodied subjects. The mean age in the SCI group was 51 years (21–79 years). The mean age in the able-bodied group was 53 years (18–80 years). Overall 98% of the SCI group had MRI appearances of AC arthritis, with 81% being graded as moderate or severe. In the able-bodied group 92% had AC arthritis, with 68% being graded as moderate or severe. The study does not report clinical symptoms and it is likely that not all cases with MRI changes were symptomatic.

In cases with symptoms, we recommend image guided cortisone injection. If symptoms are ongoing, recurrent and significant, arthroscopic AC joint debridement can be performed. We are unaware of any published data regarding outcomes in this patient population.

Glenohumeral joint instability: glenohumeral instability can be evaluated and treated along the same lines as in the able-bodied population. As in rotator cuff repair surgery, a period of immobilization, power wheelchair use and dependent transfers, is

required. Again, we are unaware of any published data regarding outcomes of shoulder instability surgery in this population.

Glenohumeral joint arthritis: glenohumeral arthritis has a range of surgical options in the able-bodied population. Symptomatic mild cases sometimes derive a period of benefit from arthroscopic debridement.[19] More severe cases may be treated with a range of arthroplasty options including resurfacing hemiarthroplasty, stemmed hemiarthroplasty, conventional total shoulder replacement and reverse shoulder arthroplasty. Specific indications are influenced by the condition of the rotator cuff and glenoid. We are unaware of published data on the outcomes of shoulder replacement in the tetraplegic population. However, shoulder arthroplasties are not considered suitable for withstanding heavy and repeated loads and the "at risk" position for instability in reverse shoulder arthroplasty is the action of transferring out of a wheelchair.

Preventative strategies

The American Consortium for Spinal Cord Medicine publishes comprehensive guidelines for the preservation of upper limb function following SCI.[2] The key points include aspects of ergonomics, equipment, training, exercise, management of injuries and pain. Education and techniques are important for safe transfers. The load and frequency of upper limb tasks should be minimized. Injurious positions should be avoided. The guidelines recommended avoiding positioning the hand above the shoulder and "extreme" positions of the shoulder, including extreme internal rotation and abduction.

Equipment recommendations include power wheelchairs, lightweight wheelchairs, and adjusting the rear axle as far forward as safely possible. They recommend positioning the arm in abduction and external rotation for periods when supine. Other recommendations included seat elevation, performing level transfers where possible and considering assistive transfer devices such as transfer boards. Medical assessment and rehabilitation were recommended as the initial approach in most cases of upper limb pain without traumatic aetiology. With regard to exercise, a program of shoulder flexibility and strengthening exercises were recommended.

Mulroy et al.[20] reported the effectiveness of a 12 week home exercise program for shoulder pain in paraplegic subjects in a randomized controlled study. They used the acronym "STOMPS" to describe their program of "Strengthening and Optimal Movements for Painful Shoulders". At 4 weeks follow up, there were significant improvements in the intervention group that were not present in the control group. It is likely, but not proven, that the STOMPS program would be beneficial in some cases of shoulder pain in tetraplegia.

Summary

Shoulder pain is common in tetraplegia. Clinical presentations and treatments for shoulder pain in tetraplegia are many and varied. Some patterns of pathology are seen that are specific to the person with tetraplegia, some may be attributable to overuse while others may be traumatic in aetiology. The treatment principles include modification of environment and shoulder loading, physiotherapy and education, sometimes injections and occasionally surgery. Treatment is ideally undertaken in the context of a spinal injuries unit where a comprehensive interdisciplinary management approach can be taken to lessen impacts of ongoing shoulder pain.

There is much that we do not understand about shoulder pain in tetraplegia and very little published regarding treatments and outcomes. Collaboration and further studies are required to improve our knowledge, to be able to more effectively help this special group of patients. ◆

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