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## SHOULDER DISORDERS AND OCCUPATION

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### Abstract

Shoulder pain is very common and causes substantial morbidity. Standardised classification systems based upon presumed patho-anatomical origins have proved poorly reproducible and hampered epidemiological research. Despite this, there is evidence that exposure to combinations of physical workplace strains such as overhead working, heavy lifting and forceful work as well as working in an awkward posture increase the risk of shoulder disorders. Psychosocial risk factors are also associated. There is currently little evidence to suggest that either primary prevention or treatment strategies in the workplace are very effective and more research is required, particularly around the cost-effectiveness of different strategies.

### Keywords

Shoulder pain; impingement syndrome; frozen shoulder (adhesive capsulitis); rotator cuff

### Introduction and Scope

According to population surveys, shoulder pain affects 18-26% of adults at any point in time [1–4], making it one of the most common regional pain syndromes. Symptoms can be persistent and disabling in terms of an individual's ability to carry out daily activities both at home and in the workplace [5,6]. There are also substantial economic costs involved, with increased demands on health care, impaired work performance, substantial sickness absence, and early retirement or job loss [7–10].

The shoulder has evolved to withstand heavy physical demands and to do so over an unusually wide range of motion. To achieve this, it is not a simple 'ball and socket' joint but rather a complex composed of four articulations and a supporting arrangement of bones, muscles and ligaments within and outside of the joint capsule. However, its complexity and the nature of the demands on it make it susceptible to a range of articular and peri-articular

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pathologies. Shoulder pain has a diverse range of causes (Table 1). In addition to local pathologies, shoulder pain may be referred from the neck causing symptoms that may be difficult to distinguish clinically from those localised to the shoulder. Moreover, pain may be experienced in the shoulder referred from abdominal pathologies affecting the diaphragm, liver or other viscera. Although referred abdominal pathologies are outwith the scope of this chapter, the range of specific shoulder disorders and overlap with neck conditions will be considered, particularly in relation to work and workers with specific occupational exposures.

## Shoulder anatomy

The extraordinary flexibility of the shoulder joint is achieved through four articulations: gleno-humeral, acromio-clavicular, sterno-clavicular and scapulo-thoracic. Stability is therefore reliant upon a functional system of musculo-tendinous support both within (the rotator cuff) and outside of the joint capsule. However, its complex design leaves it prone to injury and sprain/strain particularly under conditions in which it is excessively overloaded. For example, the physiological movement of abduction causes impingement of both the rotator cuff tendon and the long head of biceps between the greater tuberosity of the humerus and the coraco-acromial arch. Not surprisingly therefore, excessive or repetitive activities may precipitate a localised tendinopathy and rotator cuff degeneration or tears that inevitably compromise the function of the tendon in stabilising and depressing the humeral head.

## Classification systems for shoulder disorders

There has been a lengthy history of use of patho-anatomical classification systems to attempt to separate sub-types of shoulder conditions [11,12]. Since the publication of Codman's book, 'The Shoulder' in 1934 [13], the following patho-anatomical sub-categories have been widely employed: rotator cuff disease; biceps tendon disease; acromioclavicular joint abnormalities; and adhesive capsulitis. The next section will briefly discuss these 'specific' causes of shoulder pain and their diagnostic criteria as recommended in clinical practice.

### Rotator Cuff Tendinopathy

The results of post-mortem studies suggest that it is usual, by the fifth decade of life, to find degenerative changes in the rotator cuff tendons, particularly thinning and fibrillation at the 'critical zone' (the hypovascular area) of the cuff. These changes are thought to be those of physiological ageing, but it seems that under some conditions, as degeneration increases, repair mechanisms fail and micro-tears develop which can become macro-tears, and epidemiological studies suggest that these changes are a frequent cause of painful shoulder symptoms [2,14]. There may also be inflammation of the tendons or bursa. Typically, the pain is made worse by sleeping on the affected shoulder and moving the shoulder in certain directions and there can be pressure on the tendons by the overlying bone when lifting the arm up, the phenomenon described as 'impingement'. Cyriax wrote that the involved tendon could be differentiated by physical examination findings: supraspinatus tendinitis by pain on resisted abduction, infraspinatus tendinitis by pain on resisted external rotation and subscapularis tendinitis by pain on resisted internal rotation [12]. However, the evidence that

these signs perform well in clinical practice, at least in population and workplace studies, is lacking.

### **Biceps tendinopathy**

The biceps tendon is also prone to tendinopathy, resulting in anterior shoulder pain. Cyriax described the classical findings of bicipital tendinitis as pain on resisted elbow flexion (Speed's test) and pain on resisted supination of the forearm (Yergason's test) [12]. It is noteworthy that few epidemiological studies have involved an examination component which specifically attempted to discriminate bicipital tendinitis. Of those that have, most have used criteria based upon those of Cyriax: shoulder pain, local tenderness over the tendon, and pain on resisted isometric elevation of the arm and/or resisted isometric flexion of the elbow [15–18]. It is thought that isolated biceps tendinopathy is relatively uncommon and that the condition more commonly co-exists with rotator cuff pathology and impingement.

### **Adhesive capsulitis (frozen shoulder syndrome)**

The term 'frozen shoulder' appears to have been first coined by Codman in 1934, for a 'class of cases which are difficult to define, difficult to treat and difficult to explain from the point of view of pathology' [13]. Codman wrote that the primary cause was a localised supraspinatus tendinitis with subsequent extension to the other components of the rotator cuff, the subacromial bursa, and finally the capsule and extra-capsular ligaments. This view has been disputed [12], and there is generally no agreement as to the underlying pathophysiology. One arthroscopic study found histological appearances of the capsule similar to those seen in Dupuytren's contracture, suggesting that frozen shoulder may be one of the fibromatoses [19]. However, these were in a highly selected group of patients (those with severe symptoms of sufficient duration to warrant referral to orthopaedic clinics and surgical intervention).

Capsulitis has been described as having three characteristic phases. During the first painful phase, the shoulder complex is severely painful, often during rest, and this phase can last anything from 3 to 6 months. Subsequently, during the adhesive phase, pain resolves but significant restriction of movement, active and passive, occurs in all planes. In the final resolution phase, recovery of function is said to occur. The transition through these stages is thought to take an average of 30 months, but may be considerably longer and it is not clear that complete recovery occurs: one study found that as many as 50% of patients failed to regain a normal range of movement, even at follow-up after 7 years [20].

To diagnose capsulitis, Cyriax required restricted passive motion of the shoulder joint in a 'capsular pattern' – i.e. limitation of external rotation more than abduction, more than internal rotation. Broadly, the case definitions used in epidemiological surveys have paralleled this description. Chard *et al*, for example, used: 'marked restriction of all active and passive movements with external rotation reduced by at least 50% of normal, in the absence of bony restriction' [2]. Other studies have introduced the element of duration: Ohlsson *et al* [15], Viikari-Juntura [21] and Waris *et al* [22] required shoulder pain and progressive stiffness of the shoulder over a 3-4 month period. Although broadly similar, it is

noteworthy that none of these classifications included a definition of ‘normal range of movement’, or the cut-off value below which restriction would be diagnosed.

### **Acromioclavicular joint syndrome**

The acromioclavicular joint is a plane synovial joint between the clavicle and the scapula. Normal function of the joint is required for full active painless elevation of the shoulder to take place, and dysfunction causes localised pain, tenderness and swelling and pain felt maximally on full abduction of the shoulder. Horizontal adduction of the joint with the arm extended is also said to provoke local pain (the so-called ‘scarf test’) [12]. In practice, studies of shoulder disorders have rarely included diagnostic tests specific to this condition. Where they have [15,16,22], the classification criteria have been similar but not identical.

Although many of the clinical diagnostic criteria for these specific shoulder disorders have been widely published and taught, perhaps because of the complex anatomical and functional structure, there is evidence to suggest that these patho-anatomical classification systems do not generally perform reliably in practice [23–27]. Their validity, at least in population and workplace studies, has also been questioned.

### **Specific shoulder disorders and non-specific pain**

Much of the available evidence about risk factors for shoulder disorders comes from epidemiological studies. In many of these studies, data were collected using self-completed questionnaires and the outcome measure has been ‘shoulder pain’ or ‘shoulder pain lasting more than a specified time’ or ‘shoulder pain causing a specified functional impairment’, sometimes with inclusion of a mannequin diagram to confirm the pain distribution [28]. Whilst these studies have informed our knowledge of the risk of certain activities or exposures, they fail to give specific information as to which component of the shoulder complex is affected and this may have hampered progress towards identifying strategies for prevention. It is plausible that, as with other anatomical sites such as the low back, shoulder pain may be separable into sub-categories, some of which reflect specific patho-anatomical strains and for which risk factors and prevention strategies could be identifiable. Moreover, there may also be a sub-category of ‘non-specific shoulder pain’, which has different risk factors and needs other preventive strategies, rather akin to non-specific or “mechanical” low back pain. Given our current limitations in defining sub-types shown to be relevant in terms of prognosis or response to treatment, much of the literature currently available provides risk estimates for exposures in relation to shoulder pain. Using a case definition of ‘shoulder pain, discomfort, fatigue, limited movement, loss of muscle power but without a pattern allowing a specific diagnosis to be made’ there is growing evidence that ‘non-specific shoulder pain’ is more frequently found in general population and workplace studies as compared with specific shoulder conditions that have clear diagnostic features, such as rotator cuff syndrome [29]. It has been estimated for example, that non-specific shoulder pain among workers was six times more frequent than specific shoulder conditions [30].

The lack of a consistent standardised diagnostic approach has possibly hindered our understanding of the extent of the problem in the workplace and across countries, and consequently the development of effective interventions and preventive tools to reduce the

burden of musculoskeletal pain, including shoulder problems [29,31]. With this in mind, there have been a number of initiatives to try to improve diagnostic classification of upper limb disorders. One such endeavour in the UK was instigated by the Health and Safety Executive and involved a multidisciplinary group of experts with an interest in soft tissue upper limb disorders [32]. Using a Delphi technique, this group derived consensus case definitions for, among other disorders, bicipital tendinitis, rotator cuff tendinitis and adhesive capsulitis [33]. Working from these definitions, and after adding diagnostic criteria for acromioclavicular joint dysfunction and subacromial bursitis (Table 2), informed by a literature search, our group developed and tested an examination protocol suitable for use in population-based epidemiological research [34,35]. We have shown this protocol to have good reliability between observers for the detection of physical signs at the shoulder both among patients attending hospital-based soft tissue clinics (kappa coefficients 0.54 – 0.93) [34] and among adults of working-age from the general population (kappa coefficients 0.29 -0.66) [35].

This examination protocol has been used in a large population study including 6038 working-aged adults. All 411 people reporting shoulder pain were examined by a trained observer according to the Southampton protocol. Diagnoses were assigned by a computerised algorithm according to the pre-defined criteria. Marked overlap of all diagnoses was observed within the same shoulders, such that for example, 205 of the 410 subjects with a diagnosis of adhesive capsulitis also received a diagnosis of rotator cuff tendinitis and among 28 people who received a diagnosis of bicipital tendinitis, 23 also fulfilled diagnostic criteria for adhesive capsulitis. Therefore, it seemed that these criteria had poor specificity at least for the separation of individuals with sub-types of shoulder pain in a general population study [36].

In primary care in the Netherlands, van der Windt and colleagues [37] have shown that simpler clinical classification systems yielded better intra-observer reliability but the authors concluded that more research was required to demonstrate whether the clinical syndromes that they proposed (Table 1) constituted separate disorders requiring different treatment strategies [37]. A recent (2014) review of this literature by Hanchard et al similarly found insufficient evidence of usefulness to support the use of many of the diagnostic tests currently taught in clinical practice [38].

## Neck/shoulder disorders

Although some researchers endeavour to distinguish pathology at the shoulder from that at the neck, this is not always possible clinically. In a number of studies therefore, investigators have studied ‘neck and/or shoulder’ disorders, even though there may be important differences in risk factors for pain in the neck region as opposed to those for the shoulder [39]. Neck pain is a very common symptom, with an estimated annual cumulative incidence of 17.9% [40] and a lifetime prevalence of 71% [41]. Given their close anatomical proximity, symptoms arising from the neck are frequently referred to the shoulder region. At its most extreme, acute radiculopathy affecting a specific nerve root as it exits the cervical spine may cause severe neck/arm pain (brachialgia) but the majority of neck/shoulder symptoms arise from muscular tension and spasm or are associated with cervical

spondylosis, without any objective neurological signs. Cervical spondylosis is the term used to describe radiographic changes of osteoarthritis on cervical spine X-ray. Neck pain associated with restricted range of neck motion, sometimes headaches or dizziness, and possibly referred to the upper limb is a very common clinical syndrome which is variously labelled by different healthcare practitioners as 'tension neck syndrome', 'cervical myalgia', 'trapezius myalgia', 'occupational cervico-brachial disorder', and sometimes, unhelpfully as 'cervical spondylosis'. In general population surveys, radiographic spondylotic changes are common, affecting 60% of people aged >49 years [42]. However, there is poor correlation between radiographic spondylotic changes and symptoms, and it is unclear whether common regional neck pain syndromes are caused by or exacerbated by degeneration in the cervical spine. Although there is considerably less research on neck pain, there are strong parallels with 'mechanical back pain'. It is possible that radiographic investigations is as unhelpful in the evaluation of neck pain as it is in the assessment of mechanical low back pain.

One specific occupational neck condition was described by Levy as 'porter's neck' in Rhodesia in 1968, in which porters carrying 90kg sacks of meal on their heads were shown to develop cervical disc compression predisposing them to increased risk of injury [43]. More generally, neck pain is more common among workers doing strenuous physical activities involving their arms than among sedentary workers. When this evidence was systematically reviewed by Palmer and Smedley, most of the studies explored neck pain with tenderness to palpation or mixed neck/shoulder pain and there was 'moderate evidence' for causation by repetitive movements at the shoulder and by neck flexion allied with repetition [44].

In most cases of referred neck/shoulder pain, the underlying condition is unknown but the pathophysiology appears to include muscle pain and spasm. The frequency and severity of symptoms vary widely and psychosocial factors, as well as physical factors are important. The severity of radiographic spondylotic changes should not be used to inform assessment of prognosis or fitness to work. For most people, the prognosis is excellent. Management by simple analgesia, combined with physiotherapy assessment is indicated in people with prolonged or problematic symptoms. Where possible, people should continue to attend work but modification or rotation of job tasks may be required in the short- to medium-term. For desk-based workers ergonomic review of the workstation may be helpful, and for workers using display screen equipment, there are specific regulations from the Health and Safety Executive 1992 (revised 2002) with which employers need to comply [45].

## **Non-occupational risk factors for shoulder disorders**

### **Individual risk factors**

A number of individual risk factors for shoulder pain have been established. These include: female gender [46], obesity [47] older age [48] and co-existing medical disorders (eg inflammatory arthritis, polymyalgia rheumatica, fibromyalgia, multiple sclerosis, diabetes mellitus) [49]. There is growing evidence for a role of individual psychological factors (such as distress and depression) in the development of shoulder pain [50,51]. Nahit and colleagues found psychological distress was associated with a doubling of the risk of reported pain [50]. A study of prevalence rates of musculoskeletal symptoms and associated

disability in workers suggested that cultural factors such as health beliefs and expectations have an important influence on back, neck and arm pain [52]. Smoking has also been linked to musculoskeletal pain in the arm [53] and has been associated with an increased risk of long-term sickness absence (>14 days) among employees with neck-shoulder pain [9]. Possible explanations for such findings include a pharmacological effect on pain perception, damage to musculoskeletal tissues, or differences in the threshold for reporting symptoms that reflect differences in personality or illness behaviour [53,54].

### **Non-occupational mechanical factors and shoulder disorders**

Non-occupational mechanical risk factors are not the main focus of this review, but leisure or home activities may be an important source of confounding when investigating occupational risk factors for shoulder pain [55,56]. Biomechanical features of many sports have been investigated and findings indicate that both professional and recreational athletes who participate in contact sports (e.g. ice hockey) and in sports that involve repetitive overhead actions such as golf, swimming, and javelin, are at increased risk of rotator cuff tears [57,58], acromioclavicular joint dysfunction [59], and impingement syndrome [60].

## **Occupational factors and shoulder disorders**

### **Methodological limitations**

In addition to the problems of classification discussed earlier in this chapter, there are a number of other important limitations to the available occupational literature which hamper interpretation. For example, studies have adopted widely differing methodological and statistical approaches that make comparison and interpretation of findings difficult. There is considerable heterogeneity between studies with regard to the study setting, and both the characteristics and size of the population under investigation. Additionally, there has been wide variation in methods of exposure assessment. The greatest precision in measurement of workplace exposure can be achieved by video recording of an individual worker whilst they carry out each of their usual activities, and then detailed ergonomic analyses, but this is expensive and not feasible in most studies. In consequence, surrogate measures are used such as self-completed questionnaires, which are reliant on recall and accurate estimates of exposure by the individual; such estimates are of course less consistent (people tend to overestimate physical demands), even when efforts are made to validate estimates. Similarly, there has been a lack of consistent and unambiguous definitions of psychosocial workplace factors and the need for more rigorous standardised methods for conducting future studies has been emphasised [61]. Often, studies have focussed on particular occupational groups, including slaughterhouse workers, meat processing workers, care home workers, drivers, teachers, and supermarket cashiers. However, this may limit the generalizability of results to other occupational settings [62]. Many occupational studies have been cross-sectional focussing on the prevalence of shoulder pain in a particular workforce. Cross-sectional studies are prone to both recall and selection bias ("the healthy worker effect": those affected tend to get selected out of employment and so the true risk of shoulder pain associated with occupational exposures is underestimated). These studies provide information regarding the burden of musculoskeletal pain and associations with possible risk factors, but crucially cannot clearly identify the underlying cause of reported associations between occupational

exposures and the development of pain (cause-effect relationship). The growing number of prospective studies will lead to clarification of the directions of associations.

### **Occupational mechanical risk factors**

A number of workplace physical exposures have been implicated in the causation or exacerbation of shoulder disorders [56]. Important occupational exposures include: manual handling (heavy lifting, pushing, pulling, holding, carrying [63,64]); working above shoulder height [65]; repetitive work [66,67]; vibration; and working in awkward postures [46]. Interestingly, another review that explored risk factors for specific shoulder disorders and not shoulder pain, reported similar work exposures as important: handling of loads frequently or with high force, highly repetitive work, working in awkward postures and also high psychosocial job demand [68]. Amongst the specific conditions, subacromial impingement syndrome was the most frequently studied shoulder disorder.

However, the evidence is most convincing for a cumulative effect of multiple mechanical workplace exposures increasing the risk of shoulder problems [69]. Miranda and colleagues followed up a cohort of workers in Finland after a 20 year period and found an almost 4-fold increased risk of a clinically-diagnosed shoulder disorder of at least 3 month's duration among workers who were exposed to a combination of three physical factors (e.g. force, posture, overhead work) or more [46]. The risk was considerably higher among female workers with several exposures when compared to similarly exposed men. Similarly, a higher prevalence of clinically-defined rotator cuff syndrome was observed among US employees from a variety of occupational settings whose work involved a combination of physical load exposures (long duration of shoulder flexion and forceful exertion) compared with those with a single physical exposure [70]. The authors noted that the combination of different exposures did not have to be simultaneous and that it was the total number of different exposures involved in the job that was critical. A cross-sectional study of manual workers in the UK by Pope et al identified exposures to both physical and psychosocial factors that placed groups of employees at "high risk" for disabling shoulder pain [62]. The exposures were: duration of lifting weights with one hand; duration of working above shoulder level; whether the individual found work stressful; and whether the individual rated their work psychologically demanding (Figure 1). The authors highlighted the need to consider not only the interaction of the cumulative exposure to mechanical factors, but also other aspects of a particular occupation, including psychosocial factors. Investigators are increasingly adopting such an approach.

In an attempt to minimise the healthy worker effect, Harkness and colleagues prospectively studied the onset of shoulder pain in newly-employed workers [65]. They concluded that, even at an early stage of employment, exposure to mechanical factors such as lifting heavy weights, working with hands at or above shoulder level, and pushing or pulling heavy loads were independent risk factors for new onset shoulder pain.

Miranda and colleagues found that the determinants of specific shoulder conditions differed from those of non-specific reports of shoulder pain without clinical findings [30]. They reported that non-specific shoulder pain was related to psychological and psychosocial factors while specific shoulder disorders, such as rotator cuff tendinitis were associated with



work-related mechanical factors, individual factors (age and diabetes mellitus). Although this has been hypothesised to be the case for some time, more evidence is needed as the implication of this finding is that different approaches will be needed to prevention of these two types of disorder.

### **Occupational psychosocial risk factors**

There is growing evidence that psychosocial aspects of the work environment increase the possibility of job stress and ultimately lead to adverse health effects, including musculoskeletal pain [71]. Factors such as high workplace demands, low levels of control over workload and poor support from supervisors and colleagues have been implicated as work stressors [72]. However, the role and extent of the influence of psychosocial workplace factors on the development and prognosis of shoulder pain is not well understood and remains the subject of much debate. An underlying patho-physiological mechanism has not yet been determined, but a number of possible explanations have been proposed: psychosocial demands at work can result in a high level of muscle tension and muscle activity that in turn causes muscle fatigue; a worker may adopt awkward postures or use highly repetitive movements that result in pain; an employee may be unable to relax and to reduce physiological activation to resting levels during a break or after work; and there may be alteration in an individual's perception of pain and a tendency to report symptoms [72]. Bongers et al conducted a review of the role of psychosocial factors in upper limb disorders, which included shoulder/upper arm problems. The vast majority of studies reviewed were cross-sectional in design, but almost three quarters of the studies that explored the association between work related psychosocial risk factors and shoulder/upper arm problems found at least one positive association [71].

A more recent review of 18 longitudinal studies of psychosocial workplace factors on the development of neck and shoulder disorders found evidence for a cumulative effect of high job demands, low job control, a lack of social support and job strain on the incidence of symptoms [31]. The authors confined the review to prospective studies that took account of at least one physical workplace exposure because they reasoned that workers are not exposed to psychosocial factors in isolation, but rather a combination of physical and psychosocial aspects of work simultaneously. Indeed the term "job demand" encompasses a wide range of features (such as working very hard, very fast, excessive work, long periods of intense concentration, enough time to get job done, tasks often interrupted [73]). The term therefore comprises several components including physical, psychosocial, social and organisational aspects of work that require continuous physiological and psychosocial efforts [74].

There is currently uncertainty regarding the influence of other psychosocial factors such as job satisfaction, working alone or individual psychological distress as these factors have seldom been studied. However, a prospective study of newly employed workers by Nahit et al [50] found psychological distress to be associated with a doubling of the risk of self-reported shoulder pain. Psychosocial factors such as job demand, poor support from colleagues and work dissatisfaction were also positively associated with musculoskeletal pain, including that at the shoulder. They concluded that different occupational sectors are

likely to have different psychosocial work environments and that future work should clearly define the workplace setting so that comparisons in terms of relevant exposures to the specific occupational sector can be made.

A review of largely cross-sectional studies of specific shoulder disorders and work-related factors observed an association between high job demand and subacromial impingement syndrome [68]. There is evidence that individuals with rotator cuff syndrome are more likely to report low job security and to have high job structural constraints [70]. The authors recommended further study of work organisation factors (a broad term encompassing many factors including gender mix, work environment, job type, work hours, job content) to develop a more holistic assessment of psychosocial and physical workplace exposures and thus more accurately assess the impact and consequently inform preventive policies in the workplace.

### Investigation of shoulder pain

For many people who present in primary care with shoulder pain, no investigation is required. A thorough clinical history is mandatory in exploring for 'red flags' including neurological symptoms and signs, systemic symptoms suggestive of serious pathology or inflammatory rheumatic diseases or features of intra-abdominal pathology causing referred pain. Other important points in the history include: nature of onset, history of trauma, site of pain, relationship of symptoms to movement, dominant / non-dominant arm affected, bilateral symptoms, radiation, character, duration and exacerbating/relieving factors, functional impact, and effect on sleep. A careful occupational history should include name and nature of the occupation and should enquire about exposures involving the shoulder including working overhead, lifting weights, use of force/repetition, pulling/pushing and any perceived relationship of the current symptoms to these exposures. It can be useful to enquire if symptoms are better or worse when the patient takes time away from work e.g. for annual leave or at weekends.

Physical examination should focus on the neck to identify primary cervical spine pathology causing referred symptoms and neurological assessment of both upper limbs, and should involve examination of the full musculoskeletal system if there is any suggestion of an inflammatory rheumatic disease. The shoulders should be examined for posture, swelling anteriorly and posteriorly, redness, scars and any evidence of dislocation. The bony landmarks of the shoulder complex, including the axillae, should be palpated as well as peri-articular structures including the sub-acromial bursa, bicipital groove, and anterior and posterior joint margins. Active and passive motion throughout the full range of shoulder movement (flexion /extension; abduction/adduction; internal and external rotation) should be tested and normal scapular movement observed from behind. Examine specifically for a painful arc watching the face of the patient. There are, as described above, a number of clinical confirmatory tests for suspected pathologies which vary in their sensitivity and specificity. The clinical suspicion of a significant rotator cuff tear may be confirmed by the 'drop arm' test, in which the patient is unable to support the weight of their arm in 90° of abduction.

## Imaging of the shoulder

The shoulder may be imaged using plain X-ray, ultrasound scanning, MRI or MRA. Although increasingly used in clinical practice (particularly ultrasound), there is currently no evidence-based or cost-effectiveness guidance to inform the optimal use of these modalities in the investigation of shoulder pain. For most people presenting in primary care, no imaging would be required, particularly in the absence of 'red flags'. Plain X-ray may be appropriate for exclusion of fracture and/or dislocation after trauma. Plain X-ray may also show degenerative changes of the gleno-humeral or acromio-clavicular joints and calcific tendinopathy. Rotator cuff tears are best assessed using ultrasound or MRI. The use of the different techniques for assessment of rotator cuff tears prior to surgery was recently evaluated in a systematic review by the Cochrane collaboration [75]. They found 20 studies involving 1147 shoulders that allowed comparison of MRI, MRA and Ultrasound for assessing rotator cuff tears. Unfortunately, they concluded that there were significant methodological problems in these studies, hampering comparisons. Despite this, they concluded that all three techniques were similarly accurate in detecting full-thickness rotator cuff tears but that both MRI and ultrasound may have poor sensitivity for detecting partial thickness tears, and that the sensitivity of ultrasound may be much lower than that of MRI. Neither MRI nor ultrasound provides images of the extra-capsular ligament or shoulder capsule, the site of adhesive capsulitis. Only arthrography is thought to be of value in the assessment of capsulitis.

One recently-published study compared female supermarket cashiers (undertaking repetitive work) with the general female working-age population (this comprised customers at the supermarket) [48]. Participants completed a questionnaire about pain in the shoulder which was administered by an orthopaedic specialist, and then underwent ultrasound assessment of both shoulders. If the radiologist had any doubts regarding the ultrasound findings, a magnetic resonance imaging (MRI) examination was subsequently performed. Cashiers reported a higher prevalence of shoulder symptoms than controls. However, shoulder radiography of cases and controls revealed more evidence of pathology on ultrasound/MRI among controls than cases.

## Management of shoulder disorders

The majority of studies that consider treatment of shoulder disorders have been based in primary or secondary care and the primary outcome measures are typically shoulder pain and shoulder disability. Workplace outcomes are rarely included and if they are, usually only as secondary measures. Unfortunately, the same methodological shortcomings in case definition that have hampered interpretation of the risk factor literature apply equally to the studies of interventions. Table 3 summarises the principal conservative treatments for shoulder disorders together with the results of systematic reviews summarising the strength of the evidence in support of their efficacy for the treatment of shoulder pain/disability [76–86].

## Management of shoulder pain in the workplace

To date, there have been no published studies evaluating strategies for the primary prevention of shoulder disorders in the workplace. In their systematic review commissioned by Arthritis Research-UK, Palmer and co-workers found little evidence in support of workplace interventions for musculoskeletal pain [10]; the benefits observed were small and of doubtful cost-effectiveness. The median benefit amounted to 10% improved chance of returning to work or avoidance on average of 0.3-0.5 days/month of sickness absence. No intervention was clearly superior, although effort-intensive interventions were less effective than simple ones. There were, however, few large well-conducted studies and few reports with extended follow-up or economic evaluation. The literature had methodological limitations (unblinded outcome assessment, failure to analyse by intention to treat, poor randomisation protocols) and the interventions were multifactorial and included physical, psychological, social and environmental interventions aimed at the individual (e.g. exercise therapy), workplace, health care and other services to which he/she had access.

In another systematic review of studies in the workplace, Dick et al similarly found very few studies and the reviewers criticised the quality of the available studies [87]. Here again, the absence of agreed systems of diagnostic classification had hampered the researchers in developing interventions and showing benefit.

In many workplaces, ergonomic adjustments have been introduced in an attempt to reduce the physical exposure of a worker in order to prevent or alleviate musculoskeletal pain. However ergonomic interventions alone may not be sufficient to address this issue and more recently, alternative strategies have been developed with the aim of increasing a worker's physical capacity. Such physical conditioning programmes in the workplace have been developed and investigated, with promising results in terms of reducing chronic pain and disability in the upper limb among workers in a variety of occupational settings, including those performing forceful and repetitive manual tasks [88–90]. Such interventions focus on physical resistance-training using kettlebells/dumbbells and elastic resistance bands and have been found to reduce pain intensity and disability, and improve muscle strength. As part of a Cochrane review of treatments for shoulder pain, Karjalainen and colleagues reviewed the evidence for multidisciplinary biopsychosocial management of working-aged adults with neck/shoulder pain [85]. Only two studies fulfilled the inclusion criteria, both of which were considered to be too weak methodologically to provide convincing evidence of efficacy.

In another Cochrane review, evaluating conservative treatments for treating work-related complaints of the arm, neck or shoulder in adults, the reviewers included 44 studies from 62 publications involving 6580 participants [86]. However, they reported that together these studies contributed very low-quality evidence to suggest that pain, recovery, disability and sick leave were similar after exercises when compared with no treatment. They also reported low-quality evidence that ergonomic interventions did not decrease pain at short-term follow-up but did decrease pain at long-term follow-up. This was associated with a reduction in sick leave in two studies. There was no evidence of an effect on other outcomes. They

found no evidence of a consistent effect on any of the outcomes for behavioural or any other interventions.

The considerable cost implications of sickness absence due to musculoskeletal pain are a major concern for many western countries. A recent study of Danish employees observed that 20% of workers with neck-shoulder pain recorded at least one episode of sickness absence (of more than 14 consecutive days) during a two-year follow-up as compared with 13% in the total population of all employees studied [9]. Along with physical work risk factors, pain intensity and smoking were found to be important predictors of long-term sickness absence among employees with neck-shoulder pain. They recommended initiatives such as physical exercise aimed at reducing pain intensity and also the value of smoking cessation programmes in occupations with high prevalence of neck-shoulder pain.

A prediction rule and score chart have been developed that may enable general practitioners and occupational health care professionals to identify workers with shoulder pain who are at high risk for sickness absence [7]. The investigators studied a heterogeneous working population and found that long duration of sickness absence prior to the study, high intensity of shoulder pain on a 10-point visual analogue scale, perception that the pain was caused by strain or overuse during regular activities and co-existing psychological complaints were important predictors of sick leave during the 6 month follow-up. However, not all workers with musculoskeletal pain take sick leave, and under-performance and loss of productivity at work because of presenteeism (reduced productivity among employees who continue working) are also likely to have an impact on work, which is as yet extremely difficult to quantify accurately.

## Conclusion

The shoulder complex is highly flexible, capable of lifting heavy loads and functioning in several planes of movement. Unsurprisingly, shoulder pain is common in the general population and there are multiple potential causes. There is a growing body of evidence to suggest that shoulder disorders may be increased among some workers, particularly those with jobs involving combinations of exposure to: overhead work; heavy loads; vibration; forceful work and repetition. Psychosocial workplace factors are also importantly associated so that any preventive workplace initiative will need to consider both types of risk factors. To date, most of the research on management of shoulder disorders has taken place in primary or secondary care settings and occupational outcomes have rarely been included. The literature on management of shoulder disorders in the workplace is thin, but there is some promising evidence for physical conditioning programmes aiming to increase the physical capacity of the individual. More workplace research is needed and it is important that trials of new medical and surgical interventions include workplace outcomes.

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### Practice Points

1. Shoulder pain is common and has many causes
2. Research in this field has been hampered by a lack of agreed case definitions
3. Physical and psychosocial risk factors are associated with shoulder pain among workers
4. There is currently insufficient evidence that any workplace interventions are helpful for people with shoulder pain
5. High-quality research into the primary prevention and secondary treatment of shoulder pain in workers is urgently required

### Research agenda

1. The lack of an agreed system of classification of neck/shoulder disorders has considerably hampered research in this field. An international consensus should be an urgent priority.
2. This field would be much enhanced by the development of standardised approaches to the assessment of workplace factors including ergonomic and psychosocial factors that could be widely used to make research outputs comparable.
3. Studies are needed that involve workers and have primary outcome measures that are occupational e.g. sickness absence rates, presenteeism, return to full work capacity in original job.
4. It would greatly assist employers if research on primary and secondary prevention of neck/shoulder disorders was carried out with cost-effectiveness assessments.



**Figure 1.**

**Table 1**  
**Differential Diagnosis of Shoulder Pain**

<b>Referred pain</b>	
<i>Neck</i>	Mechanical neck pain
	Cervical spondylosis
	Brachialgia
<i>Intra-abdominal</i>	Liver disease
	Splenomegaly
	Perforated bowel
<i>Pulmonary</i>	Apical lung cancer
	Pulmonary oedema
	Pulmonary embolus
<i>Diaphragmatic</i>	Phrenic nerve palsy
	Pleural plaques
<i>Cardiovascular</i>	Stroke
	Acute coronary syndrome (typically left sided)
<b>Systemic disease</b>	Malignancy (primary /secondary)
	Infection (septic arthritis, Tuberculosis)
<b>Inflammatory rheumatic diseases</b>	Polymyalgia rheumatica
	Rheumatoid arthritis
	Psoriatic arthritis
	Crystal arthritis
<b>Articular pathology</b>	Osteoarthritis of gleno-humeral joint
	Osteoarthritis of acromio-clavicular joint
	Milwaukee shoulder
<b>Bone pathology</b>	Tumour (primary or secondary)
	Avascular necrosis
	Paget's disease
	Fracture
<b>Soft tissue local pathology</b>	Rotator cuff tendinopathy /Impingement syndrome
	Biceps tendinopathy
	Adhesive capsulitis
	Calcific tendinitis
	Sub-acromial bursitis

	Shoulder instability
	Labral tears
<b>Pain syndromes</b>	Fibromyalgia syndrome
	Shoulder-hand syndrome

**Table 2**  
**A comparison of nomenclature and criteria for the diagnosis of specific shoulder disorders**

Diagnostic classification and case definition	Van der Windt, 1995	HSE, 1998	Palmer / Walker-Bone, 2000	Jia et al, 2009	Hanchard, 2014
<b>Rotator cuff disease:</b> Case definitions and sub-classes:	Subacromial syndrome Sub-Classes: Rotator cuff tendinitis Chronic bursitis Rotator cuff tears	Rotator cuff tendinitis	Rotator cuff tendinitis	Sub-Classes: Tendinosis or bursitis (painful tendon – no tear) Partial-thickness tear Full-thickness tear Subscapularis tear	Sub-Classes: Sub-acromial or internal impingement Rotator cuff tendinopathy or tears
Clinical examination /tests:	No restriction of passive movement. Pain in the C5 dermatome. Painful arc during elevation. At least one positive resistance test. Bursitis: variable/ little pain, normal power Tendinitis: pain, normal power Cuff tears: little pain, loss of power	History of pain in the deltoid region <i>and</i> pain on resisted active movement (abduction – supraspinatus; external rotation – infraspinatus; internal rotation-subscapularis)	History of pain in the deltoid region <i>and</i> pain on resisted active movement (abduction – supraspinatus; external rotation – infraspinatus; internal rotation-subscapularis)	Neer impingement sign Hawkins-Kennedy impingement sign Neither has high sensitivity nor specificity for full-thickness tears	Many tests but insufficient evidence of usefulness to recommend any
<b>Acromio-clavicular joint syndrome</b>	N/A	N/A	Acromio-clavicular dysfunction	No Sub-Classes	N/A
Clinical examination /tests:	Restriction of horizontal adduction. Pain in the area of the acromioclavicular joint and/or C4 dermatome		Pain <i>and</i> tenderness over the acromio-clavicular joint <i>and</i> pain on horizontal adduction of the extended arm (cross-body adduction test)	Local tenderness ACJ Cross-body adduction test Acromio-clavicular resisted extension test Active compression test may perform better – no data	
<b>Labral conditions</b>	N/A	N/A	N/A	Sub-Classes: Anterior and posterior of the superior labrum	Glenoid labral tears
Clinical examination /tests:				Not possible to diagnose on clinical examination alone	Many tests but insufficient evidence of usefulness to recommend any
<b>Instability</b>	Remainder (including luxations)	N/A	N/A	Sub-Classes: Anterior Posterior Multidirectional	N/A
Clinical examination /tests:				ANTERIOR: Reproduction of a symptom of instability: anterior apprehension test, relocation test, surprise test >95% specific but low sensitivity POSTERIOR: 'Voluntary'	



Diagnostic classification and case definition	Van der Windt, 1995	HSE, 1998	Palmer / Walker-Bone, 2000	Jia et al, 2009	Hanchard, 2014
				subluxation with reproduction of symptoms <b>MULTIDIRECTIONAL:</b> Sulcus sign for inferior instability not formally evaluated	
<b>Biceps tendinopathy</b>	N/A	Bicipital tendinitis	Bicipital tendinitis	Sub-Classes: Biceps tenosynovitis Partial tears Tendon subluxations Biceps entrapment Isolated abnormality of biceps tendon relatively rare	Long head of biceps tendinopathy
Clinical examination /tests:		History of anterior shoulder pain <i>and</i> pain on resisted active flexion (Speed test) or supination (Yergason test) of the forearm	History of anterior shoulder pain <i>and</i> pain on resisted active flexion (Speed test) or supination (Yergason test) of the forearm	Speed test Yergason test Neither clinically diagnostic	Many tests but insufficient evidence of usefulness to recommend any
<b>Capsular syndrome</b>	Sub-Classes: Capsulitis Arthrosis				
Clinical examination /tests:	Restriction of lateral rotation, abduction and medial rotation, pain in C5 dermatome	History of pain in the deltoid region <i>and</i> equal restriction of active and passive glenohumeral movement with capsular pattern (external rotation>abduction>internal rotation)	History of pain in the deltoid region <i>and</i> equal restriction of active and passive glenohumeral movement with capsular pattern (external rotation>abduction>internal rotation)		
<b>Acute bursitis</b>					
Clinical examination /tests:	Restriction of abduction. Severe pain in C5 dermatome. Acute onset, no preceding trauma				

**Table 3**  
**Summary of selected systematic reviews of the conservative management of shoulder disorders**

Treatment modality	Case definition	Outcome measures	Summary of evidence	References
Physiotherapy interventions	Shoulder pain	Pain Stiffness Disability	Cochrane review: There is no evidence of the effect of ultrasound in shoulder pain (mixed diagnosis)	[76]
Physiotherapy interventions	Rotator cuff disease	Pain Stiffness Disability	Cochrane review: Exercise was demonstrated to be effective in terms of short term recovery (RR 7.74 (1.97, 30.32), and longer term benefit with respect to function (RR 2.45 (1.24, 4.86). Combining mobilisation with exercise resulted in additional benefit when compared to exercise alone. Laser therapy was not more effective than placebo for supraspinatus tendinitis (RR 2, 95%CI 0.98 to 4.09). There is no evidence of the effect of ultrasound alone.	[76]
Physiotherapy interventions	Adhesive capsulitis	Pain Stiffness Disability	Cochrane review: Laser therapy was demonstrated to be more effective than placebo (RR 8, 95%CI 2.11 to 30.34). There is no evidence of the effect of either ultrasound or physiotherapy alone.	[76]
Physiotherapy interventions	Calcific tendinitis	Pain Stiffness Disability	Cochrane review: Both ultrasound and pulsed electromagnetic field therapy resulted in improvement compared to placebo for pain (RR 1.81 (1.26, 2.60) and RR 19 (1.16, 12.43) respectively	[76]
Glucocorticoid injections	Rotator cuff disease	Pain Stiffness Disability	Cochrane review: Subacromial steroid injection was demonstrated to have a small benefit over placebo in some trials however no benefit of subacromial steroid injection over NSAID was demonstrated based upon the pooled results of three trials.	[77]
	Adhesive capsulitis	Pain Stiffness Disability	Cochrane review: For adhesive capsulitis, two trials suggested a possible early benefit of intra-articular steroid injection over placebo. One trial suggested short-term benefit of intra-articular corticosteroid injection over physiotherapy in the short-term (success at seven weeks RR=1.66 (1.21, 2.28)	[77] [78]

Treatment modality	Case definition	Outcome measures	Summary of evidence	References
			Data from two RCTs showed that there may be benefit from adding a single intra-articular steroid injection to home exercise in patients with < 6 months' duration. The same two trials showed that there may be benefit from adding physiotherapy (including mobilisation) to a single steroid injection. steroid combined with physiotherapy was the only treatment showing a statistically and clinically significant beneficial treatment effect compared with placebo for short-term pain (standardised mean difference -1.58, 95% credible interval -2.96 to -0.42).	
<b>Image-guided vs blind glucocorticoid injections</b>	Rotator cuff disease Adhesive capsulitis	Pain Function Range of motion Proportion of participants with overall improvement	Cochrane review: Based upon moderate evidence from five trials, our review was unable to establish any advantage in terms of pain, function, shoulder range of motion or safety, of ultrasound-guided glucocorticoid injection for shoulder disorders over either landmark-guided or intramuscular injection.	[79]
<b>Oral glucocorticoids</b>	Adhesive capsulitis	Pain Range of motion Function	Cochrane review: 'Silver' evidence that oral steroids provide significant short-term benefits in pain, range of movement of the shoulder and function but the effect may not be maintained beyond six weeks.	[80]
<b>Arthrographic distension</b>	Adhesive capsulitis	Pain Range of motion Function	Cochrane review: There is "silver" level evidence that arthrographic distension with saline and steroid provides short-term benefits (up to 12 weeks) in pain, range of movement and function. It is uncertain whether this is better than alternative interventions.	[81]
<b>Acupuncture</b>	Rotator cuff disease Adhesive capsulitis Full thickness rotator cuff tear Shoulder pain (mixed diagnoses)	Pain Range of motion Function	Cochrane review: Due to a small number of clinical and methodologically diverse trials, little can be concluded from this review. There is little evidence to support or refute the use of acupuncture for shoulder pain although there may be short-term benefit with respect to pain and function. There is a need for further well designed clinical trials.	[82]

Treatment modality	Case definition	Outcome measures	Summary of evidence	References
<b>Electrotherapy</b>	Adhesive capsulitis	Pain Function Global treatment success	Cochrane review: No comparison with placebo. Based upon low quality evidence from one trial, low-level laser therapy for six days may be more effective than placebo on global treatment success at six days. Based upon moderate quality evidence from one trial, laser therapy plus exercise for eight weeks may be more effective than exercise alone in terms of pain up to four weeks, and function up to four months.	[83]
<b>Manual therapy and exercise</b>	Adhesive capsulitis	Pain Function Patient-reported treatment success	Cochrane review: No trials of exercise vs. placebo A combination of manual therapy and exercise may not be as effective as glucocorticoid injection in the short-term (6 weeks). It is unclear whether a combination of manual therapy, exercise and electrotherapy is an effective adjunct to glucocorticoid injection or oral NSAID. Following arthrographic joint distension with glucocorticoid and saline, manual therapy and exercise may confer effects similar to those of sham ultrasound in terms of overall pain, function and quality of life, but may provide greater patient-reported treatment success and active range of motion	[84]
<b>Multidisciplinary bio-psychosocial rehabilitation</b>	Working-aged adults with neck and shoulder pain	Pain	Cochrane review: Insufficient evidence of efficacy.	[85]
<b>Conservative interventions</b>	Work-related complaints of the arm, neck or shoulder in adults	Pain Recovery Disability Sick leave	Cochrane review: Very low-quality evidence that pain, recovery, disability and sick leave are similar after exercises when compared with no treatment, with minor intervention controls or with exercises provided as additional treatment to people with work-related complaints of the arm, neck or shoulder. Low-quality evidence also showed that ergonomic interventions did not decrease pain at short-term follow-up but did decrease pain at long-term follow-up. No evidence of an effect on other outcomes. For behavioural and other interventions, there was no	[86]

Treatment modality	Case definition	Outcome measures	Summary of evidence	References
			evidence of a consistent effect on any of the outcomes.	