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Shoulder pain

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About half the population has at least one episode of shoulder pain yearly. History and clinical examination are cornerstones in the evaluation of the patient. Shoulder pain at the work place is associated with job strain: lack of control and work with elevated arms and hand tools. Clinical skills and knowledge about red and yellow flags and biomechanics are essential to perform a systematic and reliable evaluation. The diagnostic validity of clinical tests for rotator cuff tear, impingement syndrome and superior labral tears is equal or better than ultrasound and magnetic resonance imaging. Non-steroidal anti-inflammatory drugs and cortico-steroidal injections have documented short-term pain relief. Additionally, the physician should attempt to give the patient simple advice and reinforce active coping strategies. One randomized study suggests that a proper physiotherapy regimen and surgery are equally effective for the impingement syndrome. Further research should address the cost-effectiveness of diagnostic methods and treatments.

Key words: shoulder pain; clinical tests; rotator cuff tear; impingement syndrome; adhesive capsulitis; thoracic outlet syndrome; osteoarthritis; instability; sympathetic reflex dystrophy; shoulder pain after stroke.

Shoulder pain is a frequent complaint; reports of prevalence in the general population range from 70 to 260 per 1000.[1,2] In a Norwegian survey, 46% reported that they had at least one episode of shoulder complaints within the year.[3] The corresponding figure for low back pain was 53%. In another large Norwegian survey the prevalence for weekly or more frequent neck and shoulder pain was 13% in men and 25% in women.[4] A recent study from England suggests that at least one-third of those who experience shoulder, back or neck pain and had restricted normal activities for at least a week, do not visit the general practitioner or a physiotherapist.[5] According to a recent state-of-the-art review, the annual incidence of shoulder disorders is estimated at 7%, its 1-year period prevalence at 50% and its lifetime prevalence at 10%.[6] Of all new episodes of shoulder disorders presenting to primary care, symptoms may persist for up to 1 year in 40% of patients. Chronic shoulder pain in the elderly may be underestimated and not properly treated.[7] Shoulder impairment that hampers activities of daily living in the elderly may influence self-dependence. Work or leisure activities that entail raising the arms or working with hand tools increase the risk of developing shoulder pain.[8] A recent study mapped muscular engagement and postures of construction workers undertaking

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ceiling fitting. It was reported that, for a large proportion of their working time, workers had their upper arms at levels that are considered harmful in terms of shoulder load.[9] The prevalence of rotator cuff-related pain was 18% among welders compared to 2% in office clerks at a Swedish shipyard.[10]

Reviews on treatment and diagnostic criteria for shoulder pain conclude that current diagnostic tools and treatment are not evidence-based.[6,11,12] This is in contrast with recent studies that have evaluated diagnostic procedures in specialist practice. For example, clinical tests can diagnose tendon ruptures in more than 90% of the cases.[13] In clinical practice it is often difficult to ascertain the underlying disorder by one single test, and a systematic evaluation, including a combination of tests, is recommended to establish the correct diagnosis.

Disorders are classified by pathological process (tendonitis, tendinosis and rupture), by anatomical localization (rotator cuff disease, subacromial pain syndrome), by mechanism (impingement syndrome), and by aetiology (work-related shoulder pain, repetitive strain syndrome). The terminology used reflects the medical speciality consulted: industrial medicine (work-related pain), orthopaedic surgery (impingement syndrome) and radiology (peritendinitis calcarea, acromion morphology). The various strategies for classification have certain advantages and disadvantages, but the use of different terms to describe the same condition may be confusing for someone not particularly informed in this field. For example, one study found poor agreement between the diagnostic labels recorded in medical records and ICD-9 codes, suggesting that many of the terms are used interchangeably.[12] The lack of consistent terminology may also reflect the uncertain relationship between shoulder pain, radiological and histopathological findings.[14,15] The clinician should consider this knowledge when examining the patient because pain may not arise from the structure that is shown as abnormal on imaging. A comprehensive algorithm to serve as a guide for diagnostic evaluation and management of shoulder pain caused by soft-tissue disorders has been outlined.[16]

ANATOMY

Knowledge about the anatomy and biomechanics of the shoulder is essential for performing a systematic clinical examination. Normal shoulder function requires an integrated motion created by the delicate interaction of almost 30 muscles that control the joint complex which comprises three joints and the connection between scapula and thorax. Long, outer muscles, such as the deltoid, move the upper extremity. The glenoid joint is stabilized by passive forces and the rotator cuff muscles. The latter short muscles are the supra- and infra-spinatus, teres minor and subscapularis. Their tendons comprise the rotator cuff. The subacromial bursa is located between the cuff, the coracoacromial ligament and acromion. The bursa and the glenoid joint normally do not communicate unless there is a full-thickness cuff rupture.

The collateral vascularization of the shoulder is good, but the distal part of the supra-spinatus tendon is often compromised.[17] The cuff muscles are embedded in strong fascias which may explain the high intra-muscular tension recorded in these muscles compared with the trapezius muscle at submaximal and maximal loads. The blood supply is compromised when the intra-muscular pressure exceeds the capillary pressure. This is observed at 30° abduction without handload.[18] Because we usually sustain much higher loads, it is suggested that collateral circulation be maintained at a higher intra-muscular pressure. Nevertheless, prolonged work with elevated arms and

hand tools is a risk factor for developing shoulder pain and ischaemia of the short muscles.[19]

BIOMECHANICS

Compared with the hip joint, the cavity of the glenoid gives little support. The shoulder joint allows for placement of the loaded hand in various positions at various velocities. The motion of the shoulder complex is greater than that of any other joint in the body. Therefore, the neuromuscular control and soft-tissue structures must adapt to the actual demands. The lower part of the joint capsule limits external rotation when the shoulder is abducted $>40^{\circ}$ and assists in preventing forward dislocation. The resultant force of the rotator cuff muscles is horizontally directed to stabilize the humeral head in neutral position. The deltoid has a vertical force direction. Thus, in a patient with a cuff rupture the humeral head is moved upwards in abduction. Conversely, the distance between the humeral head and the acromion is increased in a patient with an injury of the axillary nerve.

Shoulder abduction to about 90° is possible without motion of the scapula. The humeroscapular rhythm describes the motion of the humerus in relation to the scapula. Individual variation and factors such as fatigue and impairment of the rotator cuff may influence this rhythm.[20] Scapular motion contributes mostly to abduction in the range from 80 to 140°. This compares with the painful arch observed in patients with impingement and suggests that the subacromial space may be compromised at this range of motion. Experimental and observational studies have shown that the subacromial space is influenced by muscular activity. One study[21] examined the subacromial space by magnetic resonance imaging (MRI) in four healthy individuals and found that it was narrowed by protraction and widened by retraction of the scapula.

Work with elevated arms increases the load on the supra- and infra-spinatus muscles.[22] These muscles are more influenced by hand load than is the deltoid muscle.[23] In a cadaver study, Wuelker et al[24] observed that lack of force in the infra-spinatus, teres minor and subscapularis muscles increased the subacromial pressure by 60%. Lack of force in the supra-spinatus muscle and current surgical technique to enlarge the subacromial space did not alter the subacromial pressure.[25]

Because the line of action frequently crosses close to the axis of rotation, some muscles change their function depending upon the position of the joint. For example, at 90° of abduction the supra-spinatus muscle contributes to external rotation and extension.

Rotation of the clavicle is important to obtain a full range of abduction, but arm elevation to about 160° is normally maintained in a patient with an ankylosis of the acromioclavicuar joint. The conoid and trapezoid ligaments strengthen the acromio-clavicular joint, but stability is normally maintained with disruption of these.

PATHOPHYSIOLOGY

Compared with muscle, collagen tissue has poorer nutrition and a slower turnover.[26,27] Tendon cells are metabolically responsive, capable of repair, and maintain the matrix composition by a balance between anabolic and catabolic processes.[28] Studies in

patients with rotator tendinosis (chronic inflammation and fibroproliferative response) have shown an increased proteoglycan synthesis and a reduced collagen content compared with normal tendons.[29] Impingement of the subacromial bursa on elevation may increase pain and contribute to chronic changes. However, primary impingement as the major aetiological factor has been questioned.[30–32] Other factors such as ischaemia and degeneration related to age and overload of the short rotator muscles may contribute to complaints.[33] In athletes the impingement syndrome is commonly secondary to an underlying laxity of the joint capsule, imbalance of the stabilizing muscles or altered neuromuscular control.[34]

Three acromial morphological types (flat, curved and hooked) that are independent of age, have been described.[35] In addition, anterior acromial spur formation and arthritic facets of the acromioclavicular joint were related to age. Another study found a strong association between distally pointing osteophytes and supra-spinatus tendon ruptures.[36]

PAIN MECHANISMS

Pain may be elicited from different tissues such as tendon, bursa, ligament and muscle. The threshold for experiencing pain depends on the individual and the circumstances. Shoulder function may be altered by pain, structural abnormality or by fear of pain. The latter means that anticipation or fear of pain afflicts the patient's behaviour or neuromuscular function.[37]

The exact source for subacromial pain is not known, but free nerve endings containing substance P and calcitonin-gene-related peptides, and mechanoreceptors have been identified in the subacromial bursa.[38,39] The supra-scapular and axillary nerves innervate the subacromial bursa and a reflex arc consisting of these nerves probably conducts proprioception related to the synergistic movement of the shoulder joint.[40]

Proliferation of fibroblasts, synovial hyperplasia and capsular fibrosis have been found in adhesive capsulitis. The following mediators were identified: growth factor β, interleukin 1β (IL-1β) and tumour necrosis factor-α (TNG-α).[41]

Lund et al[42] conducted a review of articles describing motor function in five chronic musculoskeletal pain syndromes and concluded that pain reduces agonist and increases antagonist muscle activity. In recent studies an inhibitory effect of chronic tendon related shoulder pain on motor drive has been reported.[43,44]

Practice points

- supraspinatus pain is typically located to the deltoid, but may radiate in the C6 dermatoma and may mimic radiculopathy
- diffuse pain radiating at the ulnar part of the hand may be caused by compression of nerves and vessels by the scalene muscles
- referred pain from muscles in the neck may present as shoulder pain and headache
- pain referred from sites other than the shoulder (neck, thorax, cor, lung, diaphragm or gall bladder) is usually not worsened by shoulder motion
- when pain is chronic there is often a discrepancy between clinical findings and symptoms

CLINICAL EXAMINATION

A systematic clinical examination is the cornerstone for evaluation of a patient with shoulder pain. Important features of history and clinical examination are given in the practice points.

History should pinpoint the patient's problem. Additionally, a few minutes should be spent checking for yellow and red flags. Observation of the patient undressing and careful inspection may reveal shoulder stiffness, biceps tendon tear, winging of the scapula or soft-tissue mass. The lack of awareness towards the possibility of a malignant lesion in a recent study was striking, although 11 of 16 soft-tissue sarcomas presented as a newly formed mass that should be suspected by inspection.[45]

Unless complaints are bilateral it is always helpful to compare the involved and uninvolved shoulder. Glenohumeral motion should be evaluated in patients with limited active range of abduction (Figure 1). Readers are referred to a more detailed description of history and clinical tests in the section describing specific diagnoses.

Current knowledge about the validity of actual diagnostic strategies is briefly described below. While evidence for the prognostic validity of popular diagnostic classifications of shoulder disorders is lacking, their reproducibility in most studies is poor.[6] On the contrary, excellent inter-observer agreement has been reported for Cyriax criteria.[46] Rahme et al[47] reported that a positive impingement test was associated with chronic inflammation of the subacromial bursa and success after surgery. Calis et al evaluated common tests for subacromial pain.[48] The tests included Hawkins' and Neers impingement sign (Figures 2 and 3c), horizontal adduction, painful arc, drop arm, Yergason's and Speed's tests. The tests were either highly sensitive or highly specific. It was concluded that the tests are insufficient for certain diagnoses but that they play an important part in clinical evaluation. In another study they reported low specificity and positive predictive power for MRI in diagnosing the impingement syndrome.[49] Miniaci et al found altered signal intensity of the supra- and infra-spinatus tendon on MRI in all 20 asymptomatic volunteers, aged 17–49 years, examined.[15] The authors concluded that treatment should be based on clinical findings and not on the results of imaging. A recent study found that three simple tests were predictive for rotator cuff tear: weakness in external rotation, supra-spinatus weakness and impingement (Figure 2).[13]

Glenoid labral tears have been associated with overhead throwing activities, trauma, and shoulder instability. Assessment of an athlete with shoulder pain should take into account a careful history of clicking sounds or catching, symptoms with overhead activities, reports of instability, or previous trauma. On physical examination, patients with labral tears may demonstrate objective instability with or without clicking or catching during glenohumeral rotation. A systematic clinical evaluation including the apprehension sign and crank test is the key for a correct diagnosis in 90% of

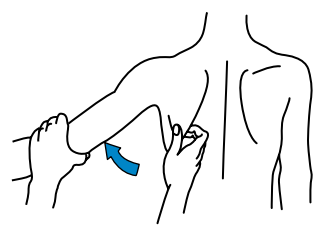

Figure 1. Passive glenohumeral joint motion is examined by fixating the scapula between the thumb and the index finger on abduction of the shoulder.

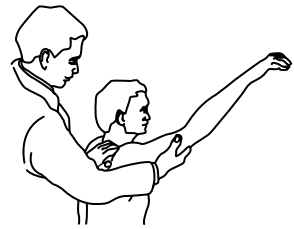

Figure 2. Neers impingement sign. The impingement sign is elicited with the patient seated and the examiner standing. Scapular rotation is prevented with one hand while the other hand raises the arm in forced forward elevation, causing the greater tuberosity to impinge against the acromion. It also causes pain in many other shoulder conditions. In the case of the impingement lesion, however, the pain caused by this maneuver is relieved by the injection of 5cc of 1% xylocaine beneath the anterior acromion.

the patients (Figures 2 and 3).[50] Physical examination is more accurate in predicting glenoid labral tears than is MRI.[51]

In this era of cost containment, completing the diagnostic work-up in the clinic without expensive ancillary studies allows the patient's care to proceed in the most timely and economic fashion. The accuracy and clinical usefulness of diagnostic imaging techniques appear to be sufficiently verified for shoulder disease in secondary care, while their clinical usefulness in primary care and prognostic validity is not. A recent review addressed the usefulness of MRI.[52] The impact on the clinician's diagnosis varied widely between four of 265 qualifying papers that addressed aspects of usefullness: the primary diagnosis was altered in 23–68% of the cases, and the management plans were subsequently changed in 15–61% of cases. Only one paper addressed the impact on patient health. It was concluded that the effectiveness of MRI of the shoulder depends on the clinical skills of the referring clinician and prevalence of the disease in the study

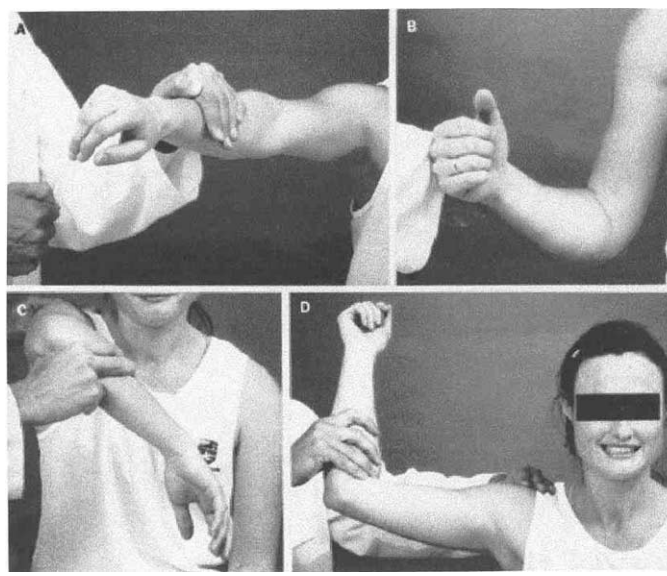

Figure 3. Tests for rotator cuff tear. A Supraspinatus weakness. B. External rotation weakness. C. Hawkins impingement sign in abduction and internal rotation. D. Hawkins impingement sign in abduction and external rotation. Three positive tests or two if the patient is aged $>$ 60 years are diagnostic for a rotator cuff tear. Negative tests exclude a rotator cuff tear.

Practice points

- listen to the patient! Do not dictate history!
- history should pinpoint the patients' problem
- check yellow and red flags and allow for a systematic and relevant clinical examination
- observe the patient carefully on undressing
- look for abnormal positioning, muscular atrophy and tumours
- always compare bilateral findings when examining the upper extremity
- patients who have a restricted active range of motion should be examined for passive glenohumeral motion of external rotation and abduction (Figure 1)
- pain provocation and muscle strength are examined by isometric/eccentric tests. Muscle strength is influenced by pain, nerve injury and tendon tear
- a positive impingement sign (Figures 2 and 3c) suggests subacromial pain in a patient with normal glenohumeral motion
- weakness in external rotation, supra-spinatus weakness on abduction and impingement indicate a rotator cuff tear (Figure 3)
- a positive apprehension sign suggests involvement of the capsular/labral complex at the extreme range of motion in the throwing athlete (Figure 4). Absence of symptoms on relocation strengthens this suspicion
- pain inhibition after subacromial lignocaine injection indicates subacromial pain (Figure 6)
- the Crank test should be performed when pain on abduction/external rotation in an athlete is not relieved by injection and the apprehension sign is negative (Figure 5)

Practice points

Red flags

- constant, progressive non-mechanical pain
- history: drug abuse, cancer, HIV
- weight loss
- violent trauma
- widespread neurological signs and symptoms
- soft-tissue mass on clinical examination

Yellow flags

- previous history of shoulder pain
- disproportionate illness behaviour
- dissatisfaction
- personal problems: alcohol, marital, financial
- adverse medico-legal proceedings
- believes that shoulder pain is dangerous
- expects passive treatment
- long-term total absence from work or sports

population. This will have implications when the effectiveness of an imaging technique between different institutions is compared, and this, in turn, will influence any comparisons of cost-effectiveness.

TREATMENT

NSAIDs, transdermal nitroglycerine and steroid injections for the shoulder have been shown to be effective for short-term outcome.[11,53–56] Steroid injections are superior to NSAIDs.[57,58] There is limited evidence for the effectiveness in shoulder disorders of physiotherapy, including exercise therapy, ultrasound, electrotherapy, laser, mobilization and manipulation.[59,60] However, a randomized, controlled trial in patients with rotator cuff disease reported that a supervised exercise regimen was better than placebo and equal to arthroscopic acromion resection.[61,62]

A recent review evaluated various physiotherapy regimens for the management of shoulder pain.[63] For several interventions and indications (e.g. thermotherapy, therapeutic exercise, massage, electrical stimulation, mechanical traction) there was a lack of evidence.

A current study reported that general practitioners (GPs) and physiotherapists trusted the following treatments: ergonomics/adjustments at work, corticosteroids, non-steroidal anti-inflammatory drugs (NSAIDs), movement exercises, acupuncture, ultrasound therapy, strengthening exercises, stretching, transcutaneous electric nerve stimulation, and superficial heat or ice therapy.[64] The trust in corticosteroids, injected in the subacromial bursa, was supported by definitive evidence for short-term efficacy. Acupuncture had tentative evidence for short-term efficacy in patients with subacromial pain.[65] The trust in ultrasound is not supported by two reviews, one of them including seven randomized studies on the efficacy of shoulder treatment.[59,60] However, ultrasound provided short-term pain relief relative to sham-ultrasound for patients with calcific tendinitis (duration less than 2 months), and pulsed electromagnetic fields (PEMF) was superior to placebo in double-blind controlled studies for the treatment of persistent rotator cuff tendinosis.[66] A recent double-blind placebo-controlled trial of moderate doses of extracorporeal shock-wave therapy (ESWT) for non-calcific tendinosis of the rotator cuff concluded that *there is a significant and sustained placebo effect* after moderate doses of ESWT in patients with non-calcific tendinosis of the rotator cuff.[67,68]

For a more detailed description of suggested treatment strategies readers are referred to the section on specific diagnoses.

Practice points

- treatment should be directed according to clinical findings and prognostic factors
- NSAIDs and steroid injections have documented short-term effects
- there is limited evidence for physiotherapy
- one randomized study found that a supervised exercise regimen was superior to placebo and equal to surgery in patients with rotator tendinosis (impingment syndrome)
- exercise programmes and advice should take into account knowledge about shoulder bio-mechanics, collagen tissue and cognitive intervention

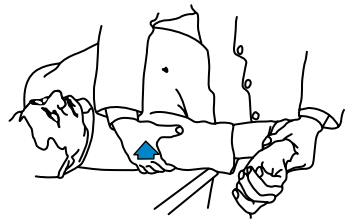

Figure 4. Apprehension/relocation test. With the patient supine and the shoulder protruding slightly from the table, the arm is placed in abduction and external rotation and the examiner gently pushes the humeral head forwards. Pain or apprehension is present in anterior instability. The test is then repeated by pushing the humeral head backwards to reduce anterior subluxation and relocate the head on the glenoid. Patients with an isolated impingement will have pain, while those with anterior instability and commonly also patients with secondary impingement will tolerate extreme external rotation when the humeral head is held in a relocated position.

Assessments

A recent study reviewed scales for measuring functional limitations and disability of the shoulder.[69] Eleven scales met minimal criteria for measurement properties. In another study the Oxford shoulder score (OSS) was compared with SF-36 and with the Constant Shoulder Score.[70] The results were in favour of the 12-item OSS and suggest that pain and

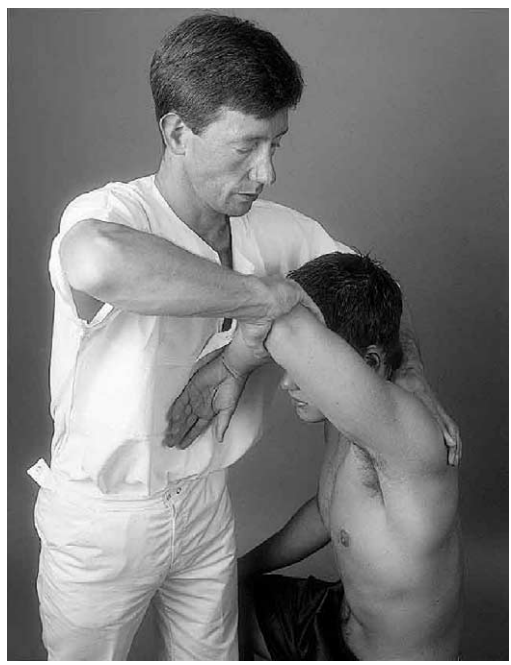

Figure 5. The Crank test is performed with the patient in the upright position with the arm elevated to 160° in the scapular plane. Joint load is applied along the axis of the humerus with one hand while the other performs humeral rotation. A positive test is determined by either pain during the maneuver (usually external rotation) with or without a click or reproduction of the symptoms, usually pain or catching felt by the patient during athletic or work activities. The test is reliable if rotator cuff impingement has been excluded by subacromial injection of 1% xylocaine.

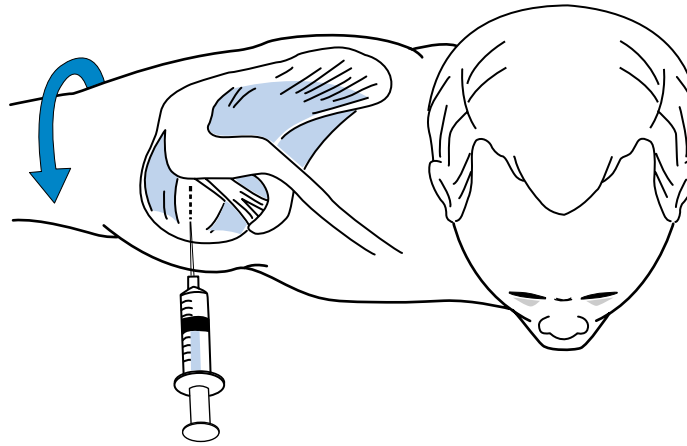

Figure 6. A subacromial injection is performed in patients with a positive impingement sign. The subacromial space is enlarged when the patient is placing his hand on the afflicted side on the back. The needle is placed in the space following the plane of the acromion and 5cc 1% xylocaine is injected. The local anaesthetics may alternatively be injected into the subacromial space from the lateral aspect of the shoulder. The test is positive if pain is markedly reduced or completely blocked on reexamination after 10 minutes.

function can be reliably assessed by a simple questionnaire. A larger questionnaire consisting of a 30-item disability-symptom scale for disabilities of the arm, shoulder and hand also provides a reliable and valid patient-centred outcome.[71] The shoulder pain and disability index (SPADI) consists of 13 questions and was more responsive than the Sickness Impact Profile for measuring shoulder related pain and disability.[72]

Clinical measures, including goniometric measurements of range of motion and composite scales such as the Constant Shoulder Score, suggest that intra- and inter-observer measurement errors are considerable.[73,74] It has been argued that disease activity, impairment, disability and pain represent different areas and must be measured separately. A study including rheumatoid arthritis (RA) patients with shoulder problems empirically found evidence for this view.[75]

The choice of outcome measure may explain the clinical results reported. In a study comparing different rating systems for shoulder pain and disability, Lirette et al found that success rates varied from 37 to 80% depending on the evaluation criteria chosen.[76] Thus, the selection of outcome measure may bias results.

For practical purposes the OSS is an example of a feasible, responsive, reliable and valid composite shoulder score.[77] A similar questionnaire has been developed for assessment of shoulder instability.[78]

ADHESIVE CAPSULITIS

A family doctor may see two or three patients with this diagnosis yearly. The disorder is idiopathic, but stress related to surgery in the neck or thorax, skin infections of the upper extremity, radiation therapy, a cerebral insult and system disorders such as diabetes or diseases of the thyroid gland may trigger its appearance. Adhesive capsulitis was found in 29% of 297 consecutive type II diabetic patients and it was associated with Dupuytren's disease.[79] Adhesive capsulitis is often called frozen shoulder because of the marked limitations in passive and active range of motion. At an early stage, symptoms and signs are usually the same as in the impingement

syndrome, but night pain and restrictions in motion are often more marked. A subacromial injection may be helpful to rule out this diagnosis. In addition, a careful history may pinpoint diagnosis. Patients with the impingement syndrome may complain that they are not able to lie on the painful shoulder, while the patient with adhesive capsulitis often wakes up due to pain when turning around in bed at night. At a later stage, range of motion is usually severely limited and rapid movements reinforce pain. Daily activities such as putting on a shirt or stretching for a seat belt in the car are often restricted.

On clinical examination all movements are usually limited. A marked reduction (at least 50% of the asymptomatic contralateral shoulder) of glenohumeral outward rotation and abduction is diagnostic (Figure 1). The patient characteristically elevates the involved side of the upper body to compensate for the reduction in joint motion.

Differential diagnoses are all other disorders characterized by reduced range of motion, for example polymyalgia rheumatica (elevated SR) and arthritis. X-rays may rule out a tumour or arthritis. Arthrography performed at presentation does not contribute to the assessment of the painful stiff shoulder[80], but a technetium-99 scan may reveal characteristic findings.[81]

The most important part of treatment is to confirm the diagnosis and to inform the patient about the natural course. The diagnosis is often delayed but is suspected when NSAIDs are not effective or physiotherapy even increases pain. The patient often believes that the shoulder will be permanently stiff and painful, so it is important to reassure the patient. The physician should emphasize that most patients will regain a normal shoulder function. The patient should be advised to use his arm, but not to do active stretching. Physiotherapy is not indicated. Intra-articular injections of glucocorticosteroids may reduce pain and their efficacy is superior to that of physiotherapy. The drug is easily injected from behind about an inch beneath the acromion, directed towards the corcacoid process (Figure 7). The injection may be repeated three or four times at intervals of 2–3 weeks. An alternative is oral drug treatment for 4–6 weeks, starting at 40–60 mg and gradually reducing the dose to 5 mg daily for the last week. It has been reported that the most refractory cases might need more aggressive interventions: arthrographic distension with local anaesthesia and steroid injection; mobilization under general or local anaesthesia, especially inter-scalene brachial plexus block; and arthroscopic release.[82] These treatments have not been evaluated and it is impossible to give any conclusive advice about the superiority of one of them.

SYMPATHETIC REFLEX DYSTROPHY OR SHOULDER–HAND SYNDROME

This syndrome is most common in females aged 40–70 years. The condition is relatively rare if the diagnostic criteria require reduced passive range of motion and tropic changes of the skin, more common when based on the criteria for complex regional pain syndrome suggested by the International Association for Pain. The syndrome has been given more than 40 different names in the Anglo-Saxon literature. Suggested risk factors are fracture at the wrist joint, surgery for carpal tunnel syndrome, heart infarction, cerebral insult, cancer, hyperlipidemy, diabetes and alcoholism. Immunological factors are likely to be involved. The association between predisposing factors and complaints is weak, suggesting that behavioural or psychological factors are important for an understanding of symptoms. Two

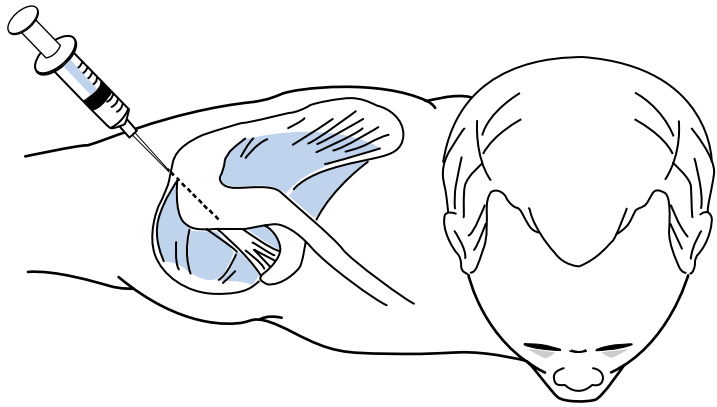

Figure 7. An intracapsular injection is injected from the posterior aspect of the shoulder with the injection site located an inch beneath the acriomion in the direction of the coracoid tubercle.

pathophysiological theories are discussed: involvement of the sympathic nerve system or an abnormal inflammatory reaction.[83]

The patient usually complains about intense pain and severe disability. At the clinical examination oedema, altered skin temperature, abnormal sweat reaction, skin atrophy of the upper extremity with shiny and red skin are characteristic. Limited passive motion of the shoulder, wrist and fingers is required to diagnose sympathetic reflex dystrophy or shoulder–hand syndrome.

More than 50 different treatments are suggested, and for most of them a 60–70% response rate is reported.[83] The patient should not be immobilized. Associated factors should be outlined. Physiotherapy, including gentle movements with a foam rubber ball, is used to stimulate hand function. Complaints from the shoulder are treated like adhesive capsulitis. The condition is usually demanding for both the patient and the therapist. Amputation of the upper extremity has been described, but results are poor. Psychosocial factors are important for prognosis. More than 30% of the patients are out of work for more than a year.

OSTEOARTHRITIS

Osteoarthritis of the glenohumeral joint is relatively rare, probably because it is a non-weight-bearing joint. Secondary osteoarthritis is related to traumatic injury of the joint (anterior shoulder dislocation) and full-thickness rotator cuff tears.

Symptoms are pain at rest and on activity, and impaired function. Range of motion may be severely limited in patients with marked osteoarthritis, but commonly the restriction is moderate. Diagnosis is based on clinical and radiological findings. In a recent study current methods for radiological evaluation showed different inter-tester reliability and did not agree for moderate arthritis. Agreement is good when joint changes are marked.[84] Ossification between the humeral head and acromion is observed in advanced cases.

Haemochromatosis, chondrocalcinosis and syringomyelia are associated with arthritis of the glenohumeral joint. Primary necrosis of the humeral head is rare.

Risk factors are prolonged treatment with glucocorticoids or steroid abuse, a cominuted fracture of the humeral head, SLE, or sickle-cell anaemia.

Conservative treatments include NSAIDs, steroid injections, physiotherapy and ergonomic advice. Shoulder prosthesis has been in use for about 50 years. A recent study including 268 patients, with a 30-month follow-up, reported a 77% success rate.[85]

GLENOHUMERAL ARTHRITIS

The glenohumeral joint is involved in most forms of arthritis such as RA, gout, Reiter's syndrome, juvenile arthritis and ankylosing spondylitis. Inflammatory diseases of the glenohumeral joint are difficult to evaluate clinically and are often hard to distinguish from other disorders of the joint. Pain on passive motion may help to differentiate between inflammatory conditions and degenerative disorders. Stiffness and pain in the shoulders are frequent early manifestations of RA. Tenderness over the coracoid process is suggestive of inflammatory disease; it is not commonly elicited in primary rotator cuff disorders. Secondary rotator cuff affliction and erosions of the glenoid labrum in RA may allow superior subluxation of the humerus and subacromial impingement. Synovitis of the acromioclavicular joint may damage the rotator cuff. A rupture of the intra-capsular long head of the biceps may be acute with pain and haematoma. Patients with RA of the glenohumeral joint usually do not develop large effusions, but a rupture of the shoulder capsule may result in diffuse oedema of the arm similar to a ruptured Baker's cyst of the knee. Septic arthritis may include systemic signs such as fever, leukocytocis and elevated ESR. Shoulder effusion is difficult to detect and is often missed. When diagnosis and treatment is problematic, aspiration may be helpful. A synovial leukocyte count above 10 000/mm^3 with a predominance of neutrophiles points strongly to a rheumatoid disorder if infection and crystal-induced synovitis can be excluded. Other acute arthritic disorders may imitate and mask sepsis, including gout, pseudogout, rheumatic fever, juvenile RA, and the oligoarthritic syndromes. Trauma and tumours may cause similar symptoms. Treatment should be directed towards the underlying disease and, in addition, follow the advice given for osteoarthritis. Impairment, disability and handicap may improve by physical training.[86]

SUBACROMIAL PAIN (IMPINGEMENT SYNDROME)

Rotator cuff disease or the impingement syndrome[87] has been classified according to its progression:

I acute inflammation (tendinitis/bursitis)
II degeneration/chronic inflammation (tendinosis)
III rupture and arthritis

The mechanism for pain may be the same in the three stages but the pathological findings are different. This classification may be too simplistic because patients may experience a rupture without previous symptoms.

ACUTE TENDONITIS/BURSITIS

This condition occurs commonly and usually is triggered by unaccustomed activity or trauma. The patient complains about intense pain in the deltoid area, sometimes radiating to the thumb. Range of motion and muscle strength may be severely reduced by reflex pain inhibition of agonist muscle activity. A subacromial injection with local anaesthetics by anterior or lateral access usually yields a complete pain block (Figure 6). A supplementary X-ray examination is indicated if a fracture is suspected.

A cortico-steroid may be added to the injection. A double-blind randomized study found that the method of anatomical injection gave 60% success compared with the method using tender or triggerpoint localization, giving 20% success.[88] NSAIDs for 3–7 days are usually sufficient and well tolerated. The patient should be advised to relieve the load by shortening lever arms, for example by moving the whole body while handling hand tools or objects in awkward positions. Sick leave for 1–2 weeks may be prescribed in patients with manual labour.

TENDINOSIS/CHRONIC SUBACROMIAL PAIN

The term impingement syndrome is used to describe this condition because subacromial soft-tissue is impinged between the acromion and the humeral head on shoulder abduction or flexion. Mechanical and dynamic factors may reduce the subacromial space. Soft-tissue calcification >16 mm was associated with pain in one survey. Soft-tissue calcifications are three times as common in patients with diabetes compared with the non-diabetic population.[89] Other factors related to subacromial pain are glenohumeral instability, thoracic kyphosis and paresis of the serratus anterior muscle.

The patient characteristically complains about pain in the deltoid area on elevation of the arm. Sleep may be disturbed when lying on the afflicted shoulder. Moderately limited range of active abduction with, and a painful arch at. 80–120° of motion is a characteristic clinical feature. Some patients may obtain a full range of motion by subluxating the humeral head through the painful arch of motion. Positive impingement signs (Figures 2 and 3), pain on isometric abduction and external rotation in combination with pain relief by subacromial injection are diagnostic. An active compression test is helpful for discriminating between labral tears/acromioclavicular pain and subacromial pain.[90] Positive and negative predictive values $>90\%$ were found.

Treatment is primarily active physiotherapy. NSAIDs, steroid injections and electrotherapy may be given supplementarily. Patients with manual labour may benefit from temporary or permanent work replacement. In a randomized study, supervised exercises were superior to placebo and were equal to surgery at a follow-up 6 and 30 months.[61,62]

Polymedication and sick leave were powerful negative predictors of short- and long-term outcome.[91] The supervised exercise regimen did not focus on pain but emphasized correction of muscular dysfunction, progressive muscular conditioning and simple ergonomic advice. In addition, the initial phase consisted of massage and repeated motion at a low mechanical load with the use of a sling fixed to the ceiling.[92] The collagen tissue adapts slowly with regard to oxidative capacity and strength strain properties. After 8–10 weeks of exercise an increase of 10% for is expected for tendons compared with up to 100% in muscles.[26] Immobilization for 6 weeks reduces strength–strain properties of the tendon by up to 40%.[27] Therefore, advice regarding physical activity in degenerative disorders should be directed at active relief and mobilization.

ROTATOR CUFF TEARS

Rotator cuff tears account for almost 50% of major shoulder injuries.[13] The prevalence of partial- or full-thickness ruptures increases markedly after 50 years of age. Ruptures were present in over 50% of dominant shoulders in the seventh decade on ultrasound examination in a comprehensive study of an asymptomatic population.[93] The authors concluded that rotator cuff lesions are a natural correlate of ageing, often present with no clinical symptoms. The authors concluded that treatment should be based on clinical findings and not on the results of imaging. The supra-spinatus tendon is more commonly involved than the other tendons of the cuff. Tears of the long head of the biceps and the pectoralis major are observed by inspection. Drug abuse should be suspected if the tear of the pectoralis major is observed.

A recent study found that three simple tests were predictive for rotator cuff tear: weakness in external rotation, supra-spinatus weakness and impingement (Figure 2).[13] When all three tests were positive, or if two tests were positive and the patient was aged 60 or older, the individual had a 98% chance of having a rotator cuff tear; combined absence of these features excluded this diagnosis. The drop arm sign had 98% sensitivity, but only 10% specificity. Muscle wasting, tenderness and range of motion had less predictive value. The predictive value of the combined tests of supra-spinatus weakness, weakness in external rotation and impingement is similar to that of the best studies for magnetic resonance and ultrasonography. The clinical tests are easy and convenient to do. The size of the tear is best evaluated by arthroscopy. MRI was similar to ultrasonography, and better than clinical assessment alone. Each method underestimated rotator cuff tear size by 12, 30, 33, and 38%, respectively. No method was able to determine the size of partial-thickness rotator cuff tears.[94] A simple clinical manoeuvre called the lift-off test or lag sign, reliably diagnosed or excluded clinically relevant rupture of the subscapularis tendon.[95,96] The swallowtail sign describes the patient's inability to keep the shoulder in a maximally extended position and is helpful for discriminating between paresis of the deltoid muscle and a cuff tear (Figure 8).[97]

The primary treatment is similar to that for acute tendonitis. In younger individuals it is recommended to suture total ruptures within weeks. In older individuals an evidence-based treatment strategy cannot be given because no randomized study has been performed. Some authors have indicated that the natural course is good and that information is sufficient. Alternatively, with a physiotherapy regimen shoulder function may be regained. Shoulder function may be relatively well maintained in the case of a supra-spinatus tear.[25] Surgery may include acromial resection and osteosuture of the cuff. Recent studies suggest that early intervention may result in better clinical results and a moderate reversal of fatty muscle degeneration.[98]

INSTABILITY

While dislocation means a complete separation of joint surfaces, a subluxation describes a symptomatic joint motion without a dislocation. A dislocation will often recur in young people. Although traumatic shoulder dislocations are most common, with an incidence of 1.7% and including about 45% of all joint dislocations, readers are referred to textbooks or reviews for a comprehensive description.[34] Readers are reminded that concurrent nerve injuries may be overlooked, and that posterior dislocations are often not recognized. A common sign of the latter is a history of trauma and an altered contour of the humeral head compared with the uninvolved side.

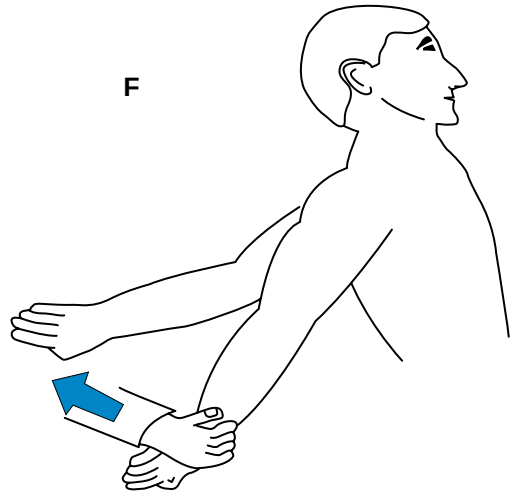

Figure 8. The swallow tail sign. The examiner maximally extends both shoulders and then asks the patient to maintain this position. A patient with an injury of the axillary nerve and a paretic deltoid muscle is unable to keep the shoulder extended. The afflicted extremity drops down and the position of the two arms resembles a swallow tail.

Posterior dislocations in children with neuromuscular disorders are commonly atraumatic instability. Anterior atraumatic dislocations are often bilateral and multidirectional.

The term 'functional instability' is commonly used, although it is not precisely defined. Although this concept is not well defined, it has contributed to a shift from focusing on inflammatory medication and surgery for enlarging the subacromial space to treat the impingement syndrome to a more dynamic approach focusing on the stabilizing structures. Injury, fatigue and pain may influence neuromuscular control and thereby reduce glenohumeral stability. For example, an injury of the long thoracic nerve, resulting in paresis of the serratus anterior muscle, alters the position of the glenoid by winging of the scapula from the thoracic wall.

Voluntary dislocations are commonly painless and may be associated with personality or psychiatric disorders. In insurance or compensation cases, voluntary dislocations may be attributed to trauma if history is not properly outlined.

History should outline family history, provoking activities, apprehension and, in the case of injury, a detailed description of its mechanism. One study reported that the contralateral shoulder was unstable in 50% of the patients with a family history of shoulder dislocation and in 26% of those without.[99] Pain and apprehension is commonly related to particular activities, such as throwing. Lack of power or apprehension in abduction/external rotation may be reproduced on clinical examination. A positive apprehension/relocation test (Figure 4) or Crank test (Figure 5) suggests involvement of the anterior or the superior glenoid labrum, respectively.[50] Patients with multidirectional and voluntary instability should be examined for the hypermobility syndrome. This is defined by thumb abduction to the wrist; hyperextension of the MCP joint of the 5.finger >90; hyperextension of the elbow and knee $>10°$; forward flexion of the trunk with straight knees; and palm of the hand at the floor.[100]

A recent study observed that some asymptomatic baseball pitchers had at least 40° loss in internal rotation as compared with the non-throwing arm that was associated

with enthesopathic changes of the posterior glenoid labrum.[101] The authors concluded that unenhanced MRI of the shoulder in asymptomatic high-performance throwing athletes reveals abnormalities that may encompass a spectrum of 'non-clinical' findings.

The treatment of choice in patients with atraumatic multidirectional dislocation, subluxations or functional instability is supervised exercises to improve neuromuscular function. Open-chain exercises should be emphasized. If this is not helpful, and pain in particular positions predominates, surgical repair of an eventual labral injury may be helpful. Patients with the hypermobility syndrome should be recommended to continue ordinary physical activity, with additional NSAIDs to treat recurrent acute pain.

In patients with anterior shoulder dislocation an X-ray should be performed to exclude a concomitant fracture. Kochers' original method is excellent for reducing anterior dislocation.[102] In patients aged <30 arthroscopic lavage or a primary Bankart stabilization procedure at the first dislocation effectively reduces the risk for recurrence.[103,104] For surgical treatment of a traumatic shoulder dislocation, the open Bankart repair remains the gold standard.[105]

SHOULDER PAIN AFTER STROKE

Shoulder pain is a common complication of stroke. It can impede rehabilitation and has been associated with poorer outcomes and prolonged hospital stay. The following guidelines are based on a recent systematic review for the management of hemiplegic shoulder pain.[106] Although a complex variety of physical changes are associated with hemiplegic shoulder pain, these broadly divide into 'flaccid' and 'spastic' presentations. Management should vary accordingly, each presentation requiring different approaches for handling, support and intervention. In the flaccid stage, the shoulder is prone to inferior subluxation and vulnerable to soft-tissue damage. The arm should be supported at all times. During this phase the patient and the caretakers should be taught how to get out of bed without using the involved shoulder and how to use the uninvolved shoulder to support the hemiplegic extremity. Functional electrical stimulation may reduce subluxation and enhance return of muscle activity, although a current review does not support this view.[107] In the spastic stage, movement is often severely limited. Relieving spasticity and maintaining range requires expert handling; overhead exercise pulleys should never be used.

Coexisting disorders such as rotator cuff tears and adhesive capsulitis are reported in patients with hemiplegic shoulder pain. The prevalence of rotator cuff tears is high in the actual age category and may be asymptomatic. It is not known whether better primary care will reduce the prevalence of adhesive capsulitis. Local steroid injections for the treatment of the hemiplegic shoulder should be avoided unless there is clear evidence of an inflammatory lesion.

THORACIC OUTLET SYNDROME (TOS)

This syndrome describes shoulder, neck and upper limb symptoms arising from compression of collar nerves and vascular components. It has been proposed that symptoms are correlated to abnormal motion of the first rib. This may be related to stiff shoulder and neck muscles, particularly to the scalene muscles. Anatomic abnormalities described by X-ray examination or MRI have no clinical value. Clinically, the TOS is defined by fulfilling three of four criteria:

- symptoms worsened by arm elevation;
- paraesthesia located to the C8–Th1 segments;
- provocation by hands-up test: arm abducted and externally rotated, the hand continually folded and opened for 3 minutes;
- pain on palpation of the brachial plexus and the scalene muscles in the supraclavicular fossa.

Good results after conservative treatment are reported in about 80% of the patients.[108] Treatment aims at normalization of the motion of the first rib. Physiotherapy and self-management should emphasize stretching, co-ordination and strength training for collar and neck muscles. Good results after surgical resection of the first rib are reported in about 40% of patients.

NON-SPECIFIC SHOULDER PAIN

Treatment regimens are often discussed in detail, while potential treatment strategies such as sick leave are continued for long periods. The costs for absenteeism and disablement constitute the largest part of the costs due to musculoskeletal disease.[109] A recent study including patients with shoulder and neck pain found that long-term sickness absence was associated with work conditions rather than with individual characteristics.[110] This is in agreement with a recent review on upper limb pain. High levels of stress and excessive demands in the job, and non-work-related stress reactions, were consistently associated with upper limb pain.[111] Another recent review on occupational shoulder pain identified 29 studies, but included, only three case–control studies.[112] Risk factors were repetitive movements, vibration duration of employment, high psychological demands, and poor control at work, poor social support, or job dissatisfaction. A firm conclusion on the role of these factors in the aetiology of upper extremity pain is not possible owing to the cross-sectional nature of most studies available.

Large epidemiological studies have indicated that social class contributes to differences in sickness absence.[113,114] Furthermore, the rate and duration of sick leave is affected by characteristics of the physician.[115]

Passive coping strategies such as sick leave and polymedication have been found to have a negative impact on outcome.[91] Although certain types of work are obviously difficult to perform with a painful shoulder, and painkillers may have short-term benefits, the negative effects of sick leave and medication should be considered.

Polymedication is common in patients with chronic pain[116], but it is often underestimated and unrecognized. Regular use of large amounts of drugs is often not taken into consideration when treatment is planned. A recent study identified a subgroup on polymedication for shoulder pain. The pharmacological properties of drugs such as non-opiates, combined with psychotrophic additives such as codeine, can lead to habituation and mental as well as physical dependency. Because patients with chronic pain suffer from insomnia, benzodiazepines are frequently prescribed for long periods. Low-dose dependency is characterized by the patient's inability to withdraw benzodiazepines after long-term treatment.[117] The analgesic effect of benzodiazepines has not been demonstrated[117], and such medication should not be prescribed for chronic shoulder pain.

It is a paradox that polymedication and sickness leave, commonly prescribed by the physician, may actually hamper the prognosis.

Nijhof[118] pointed out the interaction between the patient and the medical system as a cause for development of chronic musculoskeletal illness. He suggested chronicity to be a result of an accepted self-labelling process, in which the 'instruments' for self-labelling stem from sources within society. An editorial in the *British Medical Journal*[119] proposed a new paradigm for the treatment of acute low back pain: limited imaging and early return to normal activities. Exercises are recommended in patients who have not returned to ordinary activities and work by 6 weeks in order to treat chronic pain and prevent recurrences. Although low back pain and shoulder pain are different conditions, the major shift from the earlier paradigm of rest and pain-contingent treatment advocated in the recent editorial is in keeping with current trends for the treatment of chronic pain.

Particular attention has been paid to upper trapezius myalgia. A clear relationship between muscle tension caused by ergonomic or psychological factors and pain at the workplace has not been found, but individual reactivity to physical and psychological stressors may be causative.[120,121] A recent randomized study found that the long-term effect of all the training programmes for trapezius myalgia in women was low. Pain in the neck and shoulder muscles was persistent in a large proportion of the women over the 3 years.[122]

Chronic pain behaviour is associated with a variety of psychosocial problems. Different components have been identified: anxiety, attention seeking, verbal pain complaint, medication use, general verbal complaints, distorted posture and mobility, fatigue, insomnia and depressive mood. Although a thorough examination should be undertaken to identify an eventual underlying diagnosis, attention should be paid to identify the problem, to set up a realistic goal and to rehabilitate the patient. However, there is little scientific evidence for the effectiveness of multidisciplinary biopsychosocial rehabilitation on neck and shoulder pain compared with other rehabilitation methods.[123]

Practice points

- listen to the patient and perform a systematic clinical examination
- focus on positive factors and functions in daily life
- attempt to improve the patient's self-image and self-confidence
- underscore the patient's responsibility in the rehabilitation process
- help the patient to address the problem
- encourage the patient with moderate symptoms to return to work and physical activity
- consider the possibility of a referral to an occupational physician

Research agenda

- address the prevalence of specific shoulder disorders and non-specific shoulder pain in the general population
- evaluate diagnostic tests
- carry out high-quality studies evaluating common treatment procedures

- examine the validity of tendon abnormalities visualized by ultrasound and MRI in cross-sectional and longitudinal studies
- evaluate diagnostic skills and various diagnostic modalities in primary health care and various specialities
- carry out clinical trials comparing treatments for rotator cuff tear
- carry out trials comparing the natural course and various treatments for adhesive capsulitis
- there is an urgent need for high-quality studies to evaluate various treatment strategies for non-specific shoulder pain

REFERENCES

1 Bjelle A. Epidemiology of shoulder problems. *Baillière's Clinical Rheumatology* 1989; **3:** 437–451.
2. Bergenudd H, Lindgarde F, Nilsson B et al. Shoulder pain in middle age. A study of prevalence and relation to occupational work load and psychosocial factors. *Clinical Orthopaedics and Related Research* 1988: 234–238.
3. Natvig B, Nessiøy I, Bruusgaard D et al. Musculoskeletal symptoms in a local community. *European Journal of General Practice* 1995; **1:** 25–28.
4. Hasvold T & Johnsen R. Headache and neck or shoulder pain–frequent and disabling complaints in the general population. *Scandinavian Journal of Primary Health Care* 1993; **11:** 219–224.
5. Lock C, Allgar V, Jones K et al. Prevalence of back, neck and shoulder problems in the inner city: implications for the provision of physiotherapy services in primary healthcare. *Physiotherapy Research International* 1999; **4:** 161–169.
6. van der Heijden GJ. Shoulder disorders: a state-of-the-art review. *Baillière's Clinical Rheumatology* 1999; **13:** 287–309.
7. Chard MD, Hazleman R, Hazleman BL et al. Shoulder disorders in the elderly: a community survey. *Arthritis and Rheumatism* 1991; **34:** 766–769.
8. Hagberg M & Wegman DH. Prevalence rates and odds ratios of shoulder–neck diseases in different occupational groups. *British Journal of Industrial Medicine* 1987; **44:** 602–610.
9. Sporrong H, Sandsjo L, Kadefors R et al. Assessment of workload and arm position during different work sequences: a study with portable devices on construction workers. *Applied Ergonomics* 1999; **30:** 495–503.
* 10. Herberts P, Kadefors R, Andersson G et al. Shoulder pain in industry: an epidemiological study on welders. *Acta Orthopaedica Scandinavica* 1981; **52:** 299–306.
* 11. Green S, Buchbinder R, Glazier R et al. Interventions for shoulder pain. *Cochrane Database Systematic Reviews* 2000; **2:** CD001156.
12. Buchbinder R, Goel V & Bombardier C. Lack of concordance between the ICD-9 classification of soft tissue disorders of the neck and upper limb and chart review diagnosis: one steel mill's experience. *American Journal of Industrial Medicine* 1996; **29:** 171–182.
* 13. Murrell GA & Walton JR. Diagnosis of rotator cuff tears. *Lancet* 2001; **357:** 769–770.
14. Olsson O. Degenerative changes of the shoulder joint and their connection with shoulder pain. University of Gothenborg; 1953.
15. Miniaci A, Dowdy PA, Willits KR et al. Magnetic resonance imaging evaluation of the rotator cuff tendons in the asymptomatic shoulder. *American Journal of Sports Medicine* 1995; **23:** 142–145.
16. Uhthoff HK & Sarkar K. An algorithm for shoulder pain caused by soft-tissue disorders. *Clinical Orthopedics and Related Research* 1990; **254:** 121–127.
17. Lohr JF & Uhthoff HK. The microvascular pattern of the supraspinatus tendon. *Clinical Orthopaedics and Related Research* 1990; **254:** 35–38.
18. Järvholm U, Styf J, Suurkula M et al. Intramuscular pressure and muscle blood flow in supraspinatus. *European Journal of Applied Physiology and Occupational Physiology Occup Physiol* 1988; **58:** 219–224.
19. Herberts P, Kadefors R, Högfors C et al. Shoulder pain and heavy manual labor. *Clinical Orthopaedics and Related Research* 1984: 166–178.
20. McQuade KJ, Dawson J & Smidt GL. Scapulothoracic muscle fatigue associated with alterations in scapulohumeral rhythm kinematics during maximum resistive shoulder elevation. *Journal of Orthopaedic and Sports Physical Therapy* 1998; **28:** 74–80.

21. Solem-Bertoft E, Thuomas KA & Westerberg CE. The influence of scapular retraction and protraction on the width of the subacromial space. An MRI study. *Clinical Orthopaedics and Related Research* 1993; **296:** 99–103.
22. Järvholm U, Palmerud G, Karlsson D et al. Intramuscular pressure and electromyography in four shoulder muscles. *Journal of Orthopedic Research* 1991; **9:** 609–619.
* 23. Palmerud G, Forsman M, Sporrong H et al. Intramuscular pressure of the infra- and supraspinatus muscles in relation to hand load and arm posture. *European Journal of Applied Physiology* 2000; **83:** 223–230.
24. Wuelker N, Wirth CJ, Plitz W et al. A dynamic shoulder model: reliability testing and muscle force study. *Journal of Biomechanics* 1995; **8:** 489–499.
25. Wuelker N, Roetman B & Roessig S. Coracoacromial pressure recordings in a cadaveric model. *Journal of Shoulder and Elbow Surgery* 1995; **4:** 462–467.
26. Tipton CM, Matthes RD, Maynard JA et al. The influence of physical activity on ligaments and tendons. *Medicine and Science in Sports* 1975; **7:** 165–175.
27. Woo SL, Gomez MA, Woo YK et al. Mechanical properties of tendons and ligaments. II. The relationships of immobilization and exercise on tissue remodeling. *Biorheology* 1982; **19:** 397–408.
28. Cawston TE, Riley GP & Hazleman BL. Tendon lesions and soft tissue rheumatism—great outback or great opportunity? *Annals of the Rheumatic Diseases* 1996; **55:** 1–3.
* 29. Riley GP, Harrall RL, Constant CR et al. Tendon degeneration and chronic shoulder pain: changes in the collagen composition of the human rotator cuff tendons in rotator cuff tendinitis. *Annals of the Rheumatic Diseases* 1994; **53:** 359–366.
30. Nirschl RP. Rotator cuff tendinitis: basic concepts of pathoetiology. *Instructional Course Lecture* 1989; **38:** 439–445.
31. Fu FH, Harner CD & Klein AH. Shoulder impingement syndrome. A critical review. *Clinical Orthopaedics and Related Research* 1991; **269:** 162–173.
32. Ozaki J, Fujimoto S, Nakagawa Y et al. Tears of the rotator cuff of the shoulder associated with pathological changes in the acromion. A study in cadavera. *Journal of Bone and Joint Surgery (Am)* 1988; **70:** 1224–1230.
33. Järvholm U, Palmerud G, Herberts P et al. Intramuscular pressure and electromyography in the supraspinatus muscle at shoulder abduction. *Clinical Orthopaedics and Related Research* 1989; **245:** 102–109.
* 34. Levine WN & Flatow EL. The pathophysiology of shoulder instability. *American Journal of Sports Medicine* 2000; **28:** 910–917.
35. Nicholson GP, Goodman DA, Flatow EL et al. The acromion: morphologic condition and age-related changes. A study of 420 scapulas. *Journal of Shoulder and Elbow Surgery* 1996; **5:** 1–11.
36. Petersson CJ & Gentz CF. Ruptures of the supraspinatus tendon. The significance of distally pointing acromioclavicular osteophytes. *Clinical Orthopaedics and Related Research* 1983; **174:** 143–148.
37. Vlaeyen JW & Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. *Pain* 2000; **85:** 317–332.
38. Santavirta S, Konttinen YT, Antti-Poika I et al. Inflammation of the subacromial bursa in chronic shoulder pain. *Archives of Orthopaedic and Trauma Surgery* 1992; **111:** 336–340.
39. Vangsness Jr. CT, Ennis M, Taylor JG et al. Neural anatomy of the glenohumeral ligaments, labrum, and subacromial bursa. *Arthroscopy* 1995; **11:** 180–184.
40. Ide K, Shirai Y, Ito H et al. Sensory nerve supply in the human subacromial bursa. *Journal of Shoulder and Elbow Surgery* 1996; **5:** 371–382.
41. Rodeo SA, Hannafin JA, Tom J et al. Immunolocalization of cytokines and their receptors in adhesive capsulitis of the shoulder. *Journal of Orthopedic Research* 1997; **15:** 427–436.
42. Lund JP, Donga R, Widmer CG et al. The pain-adaptation model: a discussion of the relationship between chronic musculoskeletal pain and motor activity. *Canadian Journal of Physiology and Pharmacology* 1991; **69:** 683–694.
43. Brox JI, Roe C, Saugen E et al. Isometric abduction muscle activation in patients with rotator tendinosis of the shoulder. *Archives of Physical Medicine and Rehabilitation* 1997; **78:** 1260–1267.
44. Røe C, Brox JI, Saugen E et al. Muscle activation in the contralateral passive shoulder during isometric shoulder abduction in patients with unilateral shoulder pain. *Journal of Electromyography and Kinesiology* 2000; **10:** 69–77.
45. Siebenrock KA, Hertel R & Ganz R. Unexpected resection of soft-tissue sarcoma. More mutilating surgery, higher local recurrence rates, and obscure prognosis as consequences of improper surgery. *Archives of Orthopaedic and Trauma Surgery* 2000; **120:** 65–69.
46. Pellecchia GL, Paolino J & Connell J. Intertester reliability of the cyriax evaluation in assessing patients with shoulder pain. *The Journal of Orthopaedic and Sports Physical Therapy* 1996; **23:** 34–38.
47. Rahme H, Nordgren H, Hamberg H et al. The subacromial bursa and the impingement syndrome. A clinical and histological study of 30 cases. *Acta Orthopaedica Scandinavica* 1993; **64:** 485–488.

48. Calis M, Akgun K, Birtane M et al. Diagnostic values of clinical diagnostic tests in subacromial impingement syndrome. *Annals of the Rheumatic Diseases* 2000; **59:** 44–47.
49. Birtane M, Calis M & Akgun K. The diagnostic value of magnetic resonance imaging in subacromial impingement syndrome. *Yonsei Medical Journal* 2001; **42:** 418–424.
50. Liu SH, Henry MH & Nuccion SL. A prospective evaluation of a new physical examination in predicting glenoid labral tears. *American Journal of Sports Medicine* 1996; **24:** 721–725.
* 51. Liu SH, Henry MH, Nuccion S et al. Diagnosis of glenoid labral tears. A comparison between magnetic resonance imaging and clinical examinations. *American Journal of Sports Medicine* 1996; **24:** 149–154.
52. Bearcroft PW, Blanchard TK, Dixon AK et al. An assessment of the effectiveness of magnetic resonance imaging of the shoulder: literature review. *Skeletal Radiology* 2000; **29:** 673–679.
53. Vidal L, Kneer W, Baturone M et al. Meloxicame in acute episodes of soft tissue rheumatism of the shoulder. *Inflammatory Research* 2001; **50(supplement 1):** S24–S29.
54. Berrazueta JR, Losada A, Poveda J et al. Successful treatment of shoulder pain syndrome due to supraspinatus tendinitis with transdermal nitroglycerin. A double blind study. *Pain* 1996; **66:** 63–67.
55. Blair B, Rokito AS, Cuomo F et al. Efficacy of injections of corticosteroids for subacromial impingement syndrome. *Journal of Bone and Joint Surgery (Am)* 1996; **78:** 1685–1689.
56. van der Windt DA, Koes BW, de Jong BA et al. Shoulder disorders in general practice: incidence, patient characteristics, and management. *Annals of the Rheumatic Diseases* 1995; **54:** 959–964.
57. Petri M, Dobrow R, Neiman R et al. Randomized, double-blind, placebo-controlled study of the treatment of the painful shoulder. *Arthritis and Rheumatism* 1987; **30:** 1040–1045.
58. Adebajo AO, Nash P & Hazleman BL. A prospective double blind dummy placebo controlled study comparing triamcinolone hexacetonide injection with oral diclofenac 50 mg TDS in patients with rotator cuff tendinitis. *Journal of Rheumatology* 1990; **17:** 1207–1210.
59. Robertson VJ & Baker KG. A review of therapeutic ultrasound: effectiveness studies. *Physical Therapy* 2001; **81:** 1339–1350.
60. van der Windt DA, van der Heijden GJ, van den Berg SG et al. Ultrasound therapy for musculoskeletal disorders: a systematic review. *Pain* 1999; **81:** 257–271.
* 61. Brox JI, Staff PH, Ljunggren AE et al. Arthroscopic surgery compared with supervised exercises in patients with rotator cuff disease (stage II impingement syndrome). *British Medical Journal* 1993; **307:** 899–903.
62. Brox J, Gjengedal E, Uppheim G et al. Arthroscopic surgery versus supervised exercises in patients with rotator cuff disease (stage II impingement syndrome): a prospective, randomized, controlled study in 125 patients with a 2 1/2 year follow-up. *Journal of Shoulder and Elbow Surgery* 1999; **8:** 102–111.
63. Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for shoulder pain. *Physical Therapy* 2001;**81:**1719–30.
64. Johansson K, Öberg B, Adolfsson L et al. A combination of systematic review and clinicians' beliefs in interventions for subacromial pain. *British Journal of General Practice* 2002; **52:** 145–152.
65. Kleinhenz J, Streitberger K, Windeler J et al. Randomised clinical trial comparing the effects of acupuncture and a newly designed placebo needle in rotator cuff tendinitis. *Pain* 1999; **83:** 235–241.
66. Ebenbichler GR, Erdogmus CB, Resch KL et al. Ultrasound therapy for calcific tendinitis of the shoulder. *New England Journal of Medicine* 1999; **340:** 1533–1538.
67. Speed CA, Richards C, Nichols D et al. Extracorporeal shock-wave therapy for tendonitis of the rotator cuff. A double-blind, randomised, controlled trial. *Journal of Bone and Joint Surgery (Br)* 2002; **84:** 509–512.
68. Binder A, Parr G, Hazleman B et al. Pulsed electromagnetic field therapy of persistent rotator cuff tendinitis. A double-blind controlled assessment. *Lancet* 1984; **i:** 695–698.
69. Michener LA & Leggin BG. A review of self-report scales for the assessment of functional limitation and disability of the shoulder. *Journal of Hand Therapy* 2001; **14:** 68–76.
70. Dawson J, Hill G, Fitzpatrick R et al. The benefits of using patient-based methods of assessment. Medium-term results of an observational study of shoulder surgery. *Journal of Bone and Joint Surgery (Br)* 2001; **83:** 877–882.
71. Atroshi I, Gummesson C, Andersson B et al. The disabilities of the arm, shoulder and hand (DASH) outcome questionnaire: reliability and validity of the Swedish version evaluated in 176 patients. *Acta Orthopaedica Scandinavica* 2000; **71:** 613–618.
72. Heald SL, Riddle DL & Lamb RL. The shoulder pain and disability index: the construct validity and responsiveness of a region-specific disability measure. *Physical Therapy* 1997; **77:** 1079–1089.
73. Triffitt PD, Wildin C & Hajioff D. The reproducibility of measurement of shoulder movement. *Acta Orthopaedica Scandinavica* 1999; **70:** 322–324.

74. Conboy VB, Morris RW & Carr AJ. An evaluation of the Constant–Murley shoulder assessment. *Journal of Bone and Joint Surgery (Br)* 1996; **78:** 229–232.
75. Boström C, Harms-Ringdahl K & Nordemar R. Relationships between measurements of impairment, disability, pain, and disease activity in rheumatoid arthritis patients with shoulder problems. *Scandinavian Journal of Rheumatology* 1995; **24:** 352–359.
76. Lirette R, Morin F & Kinnard P. The difficulties in assessment of results of anterior acromioplasty. *Clinical Ortopaedics and Related Research* 1992; **278:** 14–16.
77. Dawson J, Fitzpatrick R & Carr A. Questionnaire on the perceptions of patients about shoulder surgery. *Journal of Bone and Joint Surgery (Br)* 1996; **78:** 593–600.
78. Dawson J, Fitzpatrick R & Carr A. The assessment of shoulder instability. The development and validation of a questionnaire. *Journal of Bone and Joint Surgery (Br)* 1999; **81:** 420–426.
79. Balci N, Balci MK & Tuzuner S. Shoulder adhesive capsulitis and shoulder range of motion in type II diabetes mellitus: association with diabetic complications. *Journal of Diabetes Complications* 1999; **13:** 135–140.
80. Binder AI, Bulgen DY, Hazleman BL et al. Frozen shoulder: an arthrographic and radionuclear scan assessment. *Annals of the Rheumatic Diseases* 1984; **43:** 365–369.
81. Senocak O, Degirmenci B, Ozdogan O et al. Technetium-99m human immunoglobulin scintigraphy in patients with adhesive capsulitis: a correlative study with bone scintigraphy. *Annals of Nuclear Medicine* 2002; **16:** 243–248.
82. Alvado A, Pelissier J, Benaim C et al. Phyisotherapy of frozen shoulder: literature review. *Annals of Readaptation Medical Physiology* 2001; **44:** 59–71.
83. Geurts AC, Visschers BA, van Limbeek J et al. Systematic review of aetiology and treatment of post-stroke hand oedema and shoulder–hand syndrome. *Scandinavian Journal of Rehabilitation Medicine* 2000; **32:** 4–10.
84. Brox JI, Lereim P, Merckoll E et al. Radiographic classification of glenohumeral arthrosis. *Acta Orthopaedica Scandinavica* 2003, in press.
85. Godeneche A, Boileau P, Favard L et al. Prosthetic replacement in the treatment of osteoarthritis of the shoulder: early results of 268 cases. *Journal of Shoulder and Elbow Surgery* 2002; **11:** 11–18.
86. Boström C, Harms-Ringdahl K, Karreskog H et al. Effects of static and dynamic shoulder rotator exercises in women with rheumatoid arthritis: a randomised comparison of impairment, disability, handicap, and health. *Scandinavian Journal of Rheumatology* 1998; **27:** 281–290.
87. Neer CS. Impingement lesions. *Clinical Orthopaedics and Related Research* 1983; **173:** 71–77.
88. Hollingworth GR, Ellis RM & Hattersley TS. Comparison of injection techniques for shoulder pain: results of a double blind, randomised study. *British Medical Journal* 1983; **287:** 1339–1341.
89. Mavrikakis ME, Drimis S, Kontoyannis DA et al. Calcific shoulder periarthritis (tendinitis) in adult onset diabetes mellitus: a controlled study. *Annals of the Rheumatic Diseases* 1989; **48:** 211–214.
90. O'Brien SJ, Pagnani MJ, Fealy S et al. The active compression test: a new and effective test for diagnosing labral tears and acromioclavicular joint abnormality. *American Journal of Sports Medicine* 1998; **26:** 610–613.
91. Brox J & Brevik J. Prognostic factors in patients with rotator cuff tendinosis (stage II impingement syndrome). *Scandinavian Journal of Primary Health Care* 1996; **14:** 100–105.
92. Bøhmer AS, Staff PH & Brox JI. Supervised exercises in relation to rotator cuff disease (impingement syndrome II and III): a treatment regimen and its rationale. *Physiotherapy Theory and Practice* 1998; **14:** 93–105.
93. Milgrom C, Schaffles M, Gilbert S & van Holsbeeck M. Rotator-cuff changes in asymptomatic adults. *Journal of Bone and Joint Surgery (Br)* 1995; **77:** 296–298.
94. Bryant L, Shnier R, Bryant C et al. A comparison of clinical estimation, ultrasonography, magnetic resonance imaging, and arthroscopy in determining the size of rotator, cuff tears. *Journal of Shoulder and Elbow Surgery* 2002; **11:** 219–224.
95. Gerber C & Krushell RJ. Isolated rupture of the tendon of the subscapularis muscle. Clinical features in 16 cases. *Journal of Bone and Joint Surgery (Br)* 1991; **73:** 389–394.
96. Hertel R, Ballmer FT, Lombert SM et al. Lag signs in the diagnosis of rotator cuff rupture. *Journal of Shoulder and Elbow Surgery* 1996; **5:** 307–313.
97. Nishijma N, Yamamuro T, Fujio K et al. The swallow-tail sign: a test of deltoid function. *Journal of Bone and Joint Surgery (Br)* 1995; **77:** 152–153.
98. Goutallier D, Postel JM, Lavau L et al. Impact of fatty degeneration of the suparspinatus and infraspinatus muscles on the prognosis of surgical repair of the rotator cuff. *Revue de Chirurgie Orthopedique et Reparatrice de l'Appareil Moteur* 1999; **85:** 668–676.
99. Dowdy PA & O'Driscoll SW. Shoulder instability. An analysis of family history. *Journal of Bone and Joint Surgery (Br)* 1993; **75:** 782–784.
100. Biro F, Gewanter HL & Baum J. The hypermobility syndrome. *Pediatrics* 1983; **72:** 701–706.

101. Miniaci A, Mascia AT, Salonen DC et al. Magnetic resonance imaging of the shoulder in asymptomatic professional baseball pitchers. *American Journal of Sports Medicine* 2002; **30:** 66–73.
102. Uglow MG. Kocher's painless reduction of anterior dislocation of the shoulder: a prospective randomised trial. *Injury* 1998; **29:** 135–137.
103. Wintzell G, Haglund-Akerlind Y, Ekelund A et al. Arthroscopic lavage reduced the recurrence rate following primary anterior shoulder dislocation. A randomised multicentre study with 1- year follow-up. *Knee Surgery, Sports Traumatology, Arthroscopy* 1999; **7:** 192–196.
104. Kirkley A, Griffin S, Richards C et al. Prospective randomized clinical trial comparing the effectiveness of immediate arthroscopic stabilization versus immobilization and rehabilitation in first traumatic anterior dislocations of the shoulder. *Arthroscopy* 1999; **15:** 507–514.
105. Tingart M, Bathis H, Bouillon B et al. Surgical therapy of traumatic shoulder dislocation. Are there evidence- based indications for arthroscopic Bankart operation? *Unfallchirurg* 2001; **104:** 894–901.
* 106. Turner-Stokes L & Jackson D. Shoulder pain after stroke: a review of the evidence base to inform the development of an integrated care pathway. *Clinical Rehabilitation* 2002; **16:** 276–298.
* 107. Price CI & Pandyan AD. Electrical stimulation for preventing and treating post-stroke shoulder pain: a systematic Cochrane review. *Clinical Rehabilitation* 2001; **15:** 5–19.
108. Lingren K-A. Conservative treatment of thoracic outlet syndrome: a 2-year follow-up. *Archives of Physical Medicine and Rehabilitation* 1997; **78:** 373–378.
109. van Tulder MV, Koes BW & Bouter LM. A cost-of-illness study of back pain in the Netherlands. *Pain* 1995; **62:** 233–240.
110. Ekberg K & Wildhagen I. Long-term sickness absence due to musculoskeletal disorders: the necessary intervention of work conditions. *Scandinavian Journal of Rehabilitation Medicine* 1996; **28:** 39–47.
* 111. Bongers PM, Kremer AM & ter Laak J. Are psychosocial factors, risk factors for symptoms and signs of the shoulder, elbow, or hand/wrist: A review of the epidemiological literature. *American Journal of Industrial Medicine* 2002; **41:** 315–342.
112. van der Windt DA, Thomas E, Pope DP et al. Occupational risk factors for shoulder pain: a systematic review. *Occupational and Environmental Medicine* 2000; **57:** 433–442.
113. North FM, Syme SL, Feeney A et al. Psychosocial work environment and sickness absence among British civil servants: the Whitehall II study. *American Journal of Public Health* 1996; **86:** 332–340.
114. Blank N & Diderichsen F. Short-term and long-term sick-leave in Sweden: relationships with social circumstances, working conditions and gender. *Scandinavian Journal of Social Medicine* 1995; **23:** 265–272.
115. Tellnes G, Sandvik L & Moum T. Inter-doctor variation in sickness certification. *Scandinavian Journal of Primary Health Care* 1990; **8:** 45–52.
116. Berndt S, Maier C & Schutz HW. Polymedication and medication compliance in patients with chronic non-malignant pain. *Pain* 1993; **52:** 331–339.
117. Dellemijn PL & Fields HL. Do benzodiazepines have a role in chronic pain management? *Pain* 1994; **57:** 137–152.
118. Nijhof G. Towards a sociological hypothesis on the accounting for chronicity. *International Journal of Health Sciences* 1992; **3:** 3–11.
119. Deyo RA. Acute low back pain: a new paradigm for management. Limited imaging and early return to normal activities. *British Medical Journal* 1996; **313:** 1343–1345.
120. Veiersted KB. Sustained muscle tension as a risk factor for trapezius myalgia. *International Journal of Industrial Ergonomics* 1994; **14:** 333–339.
121. Wærsted M, Bjørklund RA & Westgaard RH. The effect of motivation on shoulder-muscle tension in attention-demanding tasks. *Ergonomics* 1994; **37:** 363–376.
122. Waling K, Järvholm B & Sundelin G. Effects of training on female trapezius myalgia: an intervention study with a 3-year follow-up period. *Spine* 2002; **27:** 789–796.
123. Karjalainen K, Malmivaara A, van Tulder M et al. Multidisciplinary biopsychosocial rehabilitation for neck and shoulder pain among working age adults: a systematic review within the framework of the Cochrane Collaboration Back Review Group. *Spine* 2001; **26:** 174–181.