

DIAGNOSIS AT THE SHOULDER*

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Symptoms arising from the tissues at the shoulder are seldom felt at the shoulder itself. The exception is the acromio-clavicular joint. This is developed within the fourth cervical segment and cannot therefore refer pain to the arm. All the other common lesions at the shoulder affect structures derived largely from the fifth cervical segment. Hence the pain is often felt to start at the lower deltoid area and to spread to the end of the relevant dermatome, i.e. to the radial side of the wrist. Rarely it radiates as far as the base of the neck as well.

How far the pain is referred depends on the severity of the lesion. For example, in slight arthritis or tendinitis, the pain is usually felt at the upper arm only, whereas the same lesion, should it become more intense, leads to radiation of pain as far as the wrist. This extended reference is an error of perception occurring in the sensory cortex. A minor impulse stimulates a few cells in the appropriate part of the cerebral mosaic of cells corresponding to the relevant dermatome; a major impulse affects a larger number of cells, even perhaps every cell belonging to that dermatome. If so, the pain is felt over a wide area, but does not spread to the adjacent mosaic that corresponds to the segments on either side. Precise delineation of the extent of the pain thus has two values: (a) It outlines the dermatome and thus shows the examiner within which segment to look for the lesion; (b) it indicates the severity of the pathological process.

Whatever the disorder at the shoulder may be, the pain is apt to be felt at the same place. For example, whether arthritis, bursitis or tendinitis is present, the lesion lies in a structure of largely fifth cervical derivation; hence fifth cervical reference is common to each. Apart, therefore, from the pain at the very point of the shoulder that suggests the acromio-clavicular joint, where in the arm the pain is

felt has no significance, and its extent of distal reference indicates severity rather than provenance.

Possible Lesions

Pain in the shoulder and arm has 8 possible sources:

1. The shoulder joint.
2. The subdeltoid and subcoracoid bursae.
3. The muscles and tendons about the shoulder.
4. The acromio-clavicular joint.
5. The costo-coracoid fascia.
6. The humerus and scapula.
7. By reference distally from the tissues forming the base of the neck and upper thorax, including the cervical nerve-roots, the subclavian artery, the lower trunk of the brachial plexus, the first rib, the heart and the diaphragm.
8. By reference proximally from the nerve-sheaths in the arm, at the elbow or at the wrist.

EXAMINATION

The first question is: Does the pain felt at the shoulder arise from the tissues about the shoulder? The second is: If the shoulder is at fault, which of the structures there contains the lesion? The first part of the examination decides the former point, and since any patient with arm ache is complaining of pain felt within a dermatome between the fourth cervical and the second thoracic, these segments must be examined from beginning to end. The first stage of the examination, therefore, consists of a quick survey from neck to hand. If a lesion is found present in the shoulder area, this is examined more carefully next. If the pain is found to be referred to the shoulder from some other moving part, examination is concentrated there. If no abnormality, i.e. neither limited movement, pain nor weakness, is found at all, the lesion clearly lies outside the moving parts, and conditions like angina or diaphragmatic pleurisy are brought

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to mind. If all the movements are stated to hurt, or a number of contradictory movements, the question arises of a psychogenic disorder.

The examination proceeds as follows, the patient being asked as he performs each movement if it hurts and, if so, where, while the examiner notes if weakness is apparent on any of the resisted movements:

- Neck:* Active flexion, extension
Both side-flexions
Both rotations
- Scapula:* Active elevation (C3)
- Shoulder:* Active elevation (C5)
- Elbow:* Passive flexion and extension
Resisted flexion (C5 and C6) and extension (C7)
- Wrist:* Resisted flexion (C7) and extension (C6)
- Thumb:* Resisted extension (C8)
- Finger:* Resisted adduction of fourth and fifth fingers (T1)

If this examination shows that pain or weakness was elicited only on movement of the shoulder, this is examined in detail. However, if abnormality is detected on movements other than those at the shoulder, naturally the lesion is shown to lie elsewhere.

The Twelve Movements

During the clinical examination of the shoulder, 12 tests must be made. The examiner merely muddles himself if more than 12 are carried out; if less than the 12 are tested his examination is incomplete. These 12 are:

1. *Active Elevation.* The patient is asked to bring his arm up as high as he can and is asked what he feels. His active range of movement and statement on pain are noted for correlation later.

Patients do not know how the arm gets up to full elevation; most imagine that 180° of movement are present at the shoulder joint. In fact the first 90° of elevation take place at the scapulo-humeral joint. The next 60° result from rotation of the scapula. The last 30° involve adduction of the humerus, the surgical neck crossing in front of the coracoid and acromion processes, which rotation of the scapula has now made to point upwards instead of forwards. This knowledge is important in detecting psychogenic limitation of active elevation. If the scapula is mobile and its muscles intact, even if the shoulder is ankylosed, 60° of active abduction must be attainable by scapular movement alone. Since neurosis is often accompanied by limitation of abduction of the arm, any inconsistency between the findings on active, passive and resisted abduction must not be overlooked.

2. *Passive Elevation.* The examiner pushes the patient's arm up as high as possible and notes (a) whether full elevation is obtainable; (b) if it hurts; (c) if active and passive elevation correspond in range or not. With some experience he also notes that in patients with a normal joint the end of elevation has a characteristic free feel; whereas in capsular contracture the movement comes to a dull stop, rather as if a piece of tough leather were being unsuccessfully stretched.

3. *Scapulo-humeral Range.* The examiner fixes the lower angle of the scapula with his thumb applied to the patient's

mid-thorax and lifts the elbow outwards with his other hand until he feels the scapula start to move. He notes the amplitude of this angle (90° to 100°).

4. *Painful Arc.* This applies only when 90° of abduction range at the shoulder joint is present, passively or actively. The patient is asked to bring his arm up outwards and to state if, at any point in the upward movement, he feels an ache and, if so, if it disappears again or continues unchanged all the way up to full elevation.

5. *Passive Lateral Rotation.* The patient bends his elbow to a right angle and the examiner holds his forearm pointing straight forwards. The humerus is now rotated outwards, first on the good, then on the affected side. The range is usually 90°, occasionally a little more in the young, and often 10° to 20° less in the elderly. If the restriction is due merely to age, it is painless and bilateral.

If the lateral rotation is limited, the angle by which this falls short when the two sides are compared is estimated, and the examiner tests for the capsular feel. The appearance or not of pain when the extreme is reached is noted. Rarely a painful arc on rotation is noted; if so, a tender structure is being pinched.

6. *Passive Medial Rotation.* The normal range, starting from the forward position of the forearm (as above) is 90°. The examiner rotates the patient's humerus inwards and notes if full painless, full painful, or limited range is present, and in the latter case assesses the amplitude of this limitation (0° to 100°).

7. *Resisted Adduction.* The patient's elbow is brought a few inches from his side and he is then asked to pull his arm to his side as hard as he can. The examiner prevents all movement by placing one hand on the inner side of the patient's elbow, and the other on the patient's flank. The patient states if pain is evoked or not, and if so, where. The examiner notes the strength of the muscles.

8. *Resisted Abduction.* The patient pushes his elbow laterally as hard as he can; the examiner prevents all movement by one hand applied to the outer side of the patient's elbow, steadying himself with his hand at the far side of the patient's trunk. The patient states whether he feels pain or not; the examiner notes power.

9. *Resisted Lateral Rotation.* The patient bends his elbow to a right angle, the forearm pointing forwards. Keeping his elbow well into his side actively, he tries to rotate the arm outwards against the examiner's pressure applied to the patient's lower forearm (not his hand), so strongly that the shoulder joint does not move. Pain is reported; strength noted.

10. *Resisted Medial Rotation.* The same as for lateral rotation, except that the resisted movement takes place towards the trunk.

11. *Resisted Extension of the Elbow.* The patient's elbow is bent to a right angle; he then presses his forearm down against the examiner's resistance applied to his lower forearm (not the hand). Pain is mentioned; strength assessed.

12. *Resisted Flexion of the Elbow.* The same as for resisted extension, except that the patient flexes his elbow.

Radiography

Clinical examination is now complete. Those who wish it, may now inspect the radiograph, but must not expect very much help from it, and must be careful not to be misled.

Fracture, tuberculosis, neoplasm, neuropathic arthropathy, chondromatosis, and calcification are revealed. But in the ordinary case of arthritis, bursitis or tendinitis, the photograph reveals no abnormality. Moreover, the presence of a small osteophyte or an area of calcification does not imply that either is the cause of a patient's symptoms. Hence radiographic signs should be given weight only if they correspond with the findings on clinical examination. If the clinical signs suggest severe trouble, X-ray examination is of course essential, and shows the lesion clearly. If a calcified deposit is seen within the structure already singled out as that at fault considerable significance attaches; for its presence alters the treatment.

INTERPRETATION

When the pattern that emerges on clinical examination comes to be interpreted, there are 4 main divisions:

1. Limited passive movement: capsular pattern, i.e. arthritis.
2. Limited passive movement: non-capsular pattern.
3. Full passive range: one resisted movement hurts, i.e. a tendinous lesion.
4. Full passive range; weakness of one or more muscles.

CAPSULAR PATTERN: ARTHRITIS

The capsular pattern at the shoulder is: So much limitation of abduction, more limitation of lateral rotation, less limitation of medial rotation. Probable proportions are:

Arthritis	Abduction limited by	Lateral rotation limited by	Medial rotation limited by
Slight ..	10°	30°	full and painful
Medium ..	45°	60-70°	15-30°
Gross ..	70-80°	90°	45°

If clinical examination discloses the capsular pattern, arthritis is present. Five types exist:

1. Traumatic Arthritis

A minor injury is reported by a middle-aged or elderly patient. After the immediate pain has ceased, he feels little or nothing for some days, then the upper arm begins to hurt, first on certain movements only; later a constant ache sets in, soon spreading down to the elbow. Untreated, the pain and limitation of movement increase in the same way as for a freezing arthritis, but can be prevented by passive movement, started as soon as possible after the accident and continued daily until the full range has been restored. By contrast, freezing arthritis cannot be aborted however early treatment is started.

2. Freezing Arthritis

This is a remarkable phenomenon, without parallel at any other joint. Freezing arthritis usually comes on between the ages of 45 and 55. It follows, with only slight variations between one individual and another, a fixed course. 'Freezing arthritis' is a good descriptive label; for after freezing, the joint then thaws.

For no apparent reason, a middle-aged patient begins to

feel an ache at the shoulder on moving the arm. There is no pain when the arm is kept still. At this time examination reveals almost a full range of movement at the shoulder joint, each extreme hurting when tested passively; the resisted movements prove painless. After a month or two, the pain on movement becomes more severe and spreads as far as the elbow; a constant ache in the arm appears, worse at night and worse still if the patient lies on that side in bed. Limitation of movement at the shoulder joint of the capsular type is now clearly apparent. At the end of two or three months the pain has become constant and severe, reaching to the wrist. Severe pain on the slightest jarring of the joint may compel the patient to wear a sling. Examination now shows an abduction range of only 30° to 45° with corresponding limitation of rotation. The shoulder, however, never becomes strictly speaking 'frozen'; for complete fixation of the scapulo-humeral joint (which may occur in infective arthritis) is absent. No diminution in the range of movement takes place after four months.

At the end of 4 months the pain begins to ease and at the end of 6 months the constant ache has largely ceased. Once more pain is felt only when the shoulder is moved and it leaves the forearm, remaining only in the arm. The patient begins to be able to lie on that side again at night. Later still, the pain produced by movement becomes confined to the deltoid area and the range of movement begins to return to the joint. At the end of 10-16 months the patient is well; the ache has ceased and he has regained a full range of movement at the shoulder.

3. Infective Arthritis

This is the name given to rheumatoid arthritis when it affects one large joint only. The sedimentation rate is usually normal. It must be distinguished from a freezing arthritis because it responds excellently to hydrocortisone; whereas this is ineffectual in freezing arthritis. If trophic changes in the hand complicate an arthritic shoulder, the condition goes by the name of 'shoulder-hand syndrome'.

The distinguishing points are as follows, but in cases of doubt it is best to inject hydrocortisone into the joint and observe the result.

(a) *Age.* In freezing arthritis the patient is usually aged between 45 and 55, with extremes of 40 and 60. Infective arthritis can occur at any age, but in fact I have not yet met with a patient with monarticular involvement at the shoulder aged less than 25.

(b) *Other Joints.* If there is a past history of rheumatoid arthritis in other joints, the suggestion is obvious. Freezing arthritis has never, in my experience, affected the same shoulder twice, but I have known it appear at the other shoulder later; it is very rarely on both sides at the same time. Spondylitis ankylopoietica may be heralded by infective arthritis at the shoulder, or may be complicated by spread there, after the sacro-iliac joints have already become affected.

(c) *Too much Limitation.* Freezing arthritis usually stops getting worse when abduction has become 45° limited. Rarely 60° limitation of abduction is reached. Hence, less than 30° abduction range suggests infective arthritis.

(d) *Wrong timing.* If there is a marked discrepancy between the time that has elapsed since the onset and the known chronology and course of freezing arthritis, the lesion is probably infective.

(e) *Muscle Wasting*. If the deltoid is wasted, a joint lesion more severe than a mere freezing arthritis is present.

4. Osteo-arthritis

This diagnosis cannot be made by radiography. Osteo-arthritis may be absent clinically in a patient who has an osteophyte at the humeral head—the pain being due to some other lesion—or it may be present even when the photograph reveals nothing.

As a rule, osteo-arthritis in an elderly patient's shoulder is really a traumatic arthritis. The osteo-arthritic condition of the joint has rendered it sensitive to any slight injury, which lights up the arthritis. Occasionally, painful capsular contracture accompanied by crepitus appears spontaneously. If one shoulder crepitates, the other nearly always does too; this finding is consistent with a full range of painless movement at the osteo-arthritic joint.

5. Specific Arthritis

In tuberculosis the joint is completely fixed and the radiograph shows gross changes; in septic arthritis, fever is present; in neuropathic arthropathy there is a painless bony block with huge osteophyte outcrops that show clearly on the radiograph.

NON-CAPSULAR PATTERN

The presence of limitation of passive movement in other than the capsular proportions shows that a lesion other than arthritis is present. This cannot be a tendinous lesion, since it is anatomically impossible for a tendinous lesion of itself to limit passive range, though pain on voluntary movement may deceptively restrict the active range; those who test the range of passive, as well as active, movement cannot be deceived by this reluctance. The point is worth making, since the published views, shared apparently by all orthopaedic surgeons, are to the contrary. A wider adoption of diagnosis by the correlation of the responses to active, passive and resisted movement would help to correct this fundamental error.

Ten possible causes for non-capsular pattern exist; these are: Acute subdeltoid bursitis; Local neoplasm; Pulmonary neoplasm; Capsular adhesion; Subcoracoid bursitis; Contracture of the costo-coracoid fascia; Acromio-clavicular joint-strain; Fracture of first rib; Clay-shoveller's fracture; Hysteria; as follows:

1. Subdeltoid Bursitis

This is the common cause of marked limitation of movement coming on in the course of a few days. It is a relapsing condition, often bilateral, usually appearing at one or other shoulder, every 2-5 years.

The radiograph may or may not show calcification; moreover, this is often seen at the other shoulder too, even if no symptoms have as yet arisen there. Between attacks the calcification remains; after 2 to 10 years it may disappear spontaneously, but without rendering the shoulder immune to further attacks of bursitis. Symptomless calcification in this bursa may exist in a patient suffering from some unconnected lesion at the shoulder.

During the acute stage, there is severe constant pain from shoulder to wrist; as the bursitis dies down the pain becomes shorter and finally pain is felt only near the shoulder on movement. The attacks are self-limiting; there is a good deal

of pain for a week, then this eases, spontaneous cure taking from 4 to 6 weeks.

(a) *The Pattern*. Marked limitation of scapulo-humeral abduction range exists, associated with a full range of passive rotation. Rotation may be painful at its extreme, but the full range can be achieved. This rules out arthritis and brings acute subdeltoid bursitis to mind at once, since in arthritis lateral rotation is more limited than abduction. Other signs are:

(b) *No Muscle Spasm*. There is no joint lesion; hence no involuntary muscle spasm appears, limiting the range tested. The patient merely stops the movement actively when it begins to hurt too much and, if asked to bear the pain, can let the arm go a good deal further.

(c) *No Muscle Wasting*. Severe arthritis gives rise to wasting, but bursitis does not.

(d) *Tenderness*. The bursa is very tender all over its palpable extent.

(e) *Painful Arc*. During the attack, not enough abduction range exists to enable a painful arc to appear. When recovery is well advanced, and the range is restored, a painful arc can be elicited during the last week or so.

Chronic subdeltoid bursitis does not result from an acute bursitis that has not cleared up completely; it is a separate disorder.

2. Local Neoplasm

The neoplasm is nearly always secondary and infiltrates bone and muscle equally. Hence marked limitation of movement co-exists with obvious muscular weakness. If, as is usually the case, the patient appears with a recent normal radiograph, this should be repeated, say, a fortnight later.

3. Pulmonary Neoplasm

Any serious lesion is apt to produce spasm in near-by muscles. For example, a Brodie's abscess at the upper tibia sets up muscle spasm limiting movement at the knee joint; appendicitis causes rigidity of the abdominal muscles and so on.

When a pulmonary neoplasm lying antero-laterally reaches the ribs, the pectoralis major muscle tends to go into spasm. Hence the scapula is found fully mobile actively; there is a full range of scapulo-humeral abduction actively, but the patient cannot elevate his arm beyond the horizontal, nor can the examiner passively. When the reason for this discrepancy is sought, elevation of the arm beyond the horizontal is found restricted by involuntary contraction of the pectoralis major muscle. The patient is apt to arrive bringing with him a radiograph revealing no abnormality at the shoulder; the lungs should be X-rayed.

The same signs are also found in contracture of the pectoral scar after radical mastectomy.

4. Capsular Adhesion

This is uncommon; for traumatic arthritis is the usual sequel to a joint injury. The cause is usually a dislocation, which has severely torn the anterior aspect of the joint capsule. After reduction, this tear heals, but by some months later a large scar has formed, which contracts slowly. In the end this is apt to restrict lateral rotation only; hence the pattern is: 10° to 20° painful limitation of lateral rotation; full elevation; full medial rotation. Only two other conditions have this

pattern: subcoracoid bursitis (see below) and a ruptured infraspinatus tendon. In the latter case, the localized capsular contracture is a disuse phenomenon coming on after a year or so. When the resisted movements are examined, lateral rotation is found powerless.

5. *Subcoracoid Bursitis*

This is also rare, and confusingly enough gives rise to isolated limitation of lateral rotation, as does anterior capsular contracture (see above) and rupture of the infraspinatus muscle. In the latter event, power is found lost on resisted lateral rotation.

Differential diagnosis rests on (1) the absence of a history of a severe injury to the front of the joint; (2) the absence of the capsular feel and of spasm limiting the amount of lateral rotation range (the patient can, by disregarding the pain, allow rather more movement); (3) if the humerus is abducted to the horizontal, a full range of lateral rotation can be achieved in bursitis, but not, of course, without pain. In capsular contracture, it is unattainable whatever the position of the arm.

6. *Contracture of the Costo-coracoid Fascia*

This is a very common cause of limited elevation of the arm. The symptom is gradually increasing upper pectoro-scapular pain on one side only. It is provoked at first only by full elevation of the arm. After a year or two elevation becomes slightly limited, and any prolonged reaching upwards leads to some hours' or days' increased aching.

The syndrome is difficult to recognize; for the symptoms suggest a cervical-disc lesion and the signs unless carefully studied suggest a psychogenic disorder. The key to the condition is the discovery of slight limitation of elevation of the scapula.

Examination of the neck movements reveals that active side-flexion away from, and resisted side-flexion towards, the painful side hurt at the root of the neck. Upward movement of the scapula, active or passive, is painful at its extreme and slightly limited. Resisted elevation is painless. Forward movement of the scapula is usually full and painful; backward full and painless. Active and passive elevation of the arm is about 10° limited by pectoro-scapular pain, but the passive range of movement at the gleno-humeral joint is neither restricted nor painful. All the resisted shoulder movements hurt a little at the base of the neck.

This curious pattern occurs only in contracture of the costo-coracoid fascia. Inspection of the range of elevation of both scapulae together discloses limitation on the painful side and this rare condition is brought to mind. One cause is dense adhesions at the apex of one lung such as occurs in long-standing tuberculosis. However, not all cases show such a shadow. Follow-up for several years has not revealed the cause, and it would seem that in middle age unilateral idiopathic contracture can come on. The condition appears to become stationary after some years, and gross restriction of elevation has not been encountered.

7. *Acromio-clavicular Joint Strain*

In theory, the scapular movements should all hurt at their extremes, but sometimes they do not and the pattern that then emerges is rather puzzling. A full range of movement is found at the shoulder joint, each extreme hurting at the point of the shoulder. The resisted movements prove painless.

Each extreme of passive movement hurting suggests arthritis; a full range of movement negatives arthritis. This contradiction calls to mind the acromio-clavicular joint. If its superficial aspect is affected, tenderness is found there and no difficulty arises. If, however, the deep aspect of the joint is affected alone, the upper surface of the joint is not tender and there is a painful arc; hence a typical subdeltoid bursitis is closely mimicked. In some cases differential diagnosis is all but impossible clinically, and can be established only by local anaesthesia.

Ankylosis of the acromio-clavicular joint is rare and occurs in spondylitis deformans. The arm can then be abducted to the horizontal only, passively or actively, but all the movements at the scapulo-humeral joint are of full range and painless. The cause of this discrepancy becomes obvious when the examiner notes that the scapula cannot move appreciably on the chest wall.

8. *Fracture of the First Rib*

This may be a stress fracture, without history of trauma. The pain is at one side of the base of the neck and is brought on by the neck and scapular movements. Voluntary elevation of the arm stops at the horizontal, but a full passive range exists at the shoulder. The radiograph is diagnostic.

9. *Clay-shoveller's Fracture*

This is usually a traction fracture. The pain is at the centre of the lower neck. Though the neck movements scarcely hurt, the patient can hardly abduct either arm actively at all. The passive range is full. The radiograph shows avulsion of the tip of the spinous process of the seventh cervical or first thoracic vertebra.

10. *Hysteria*

The shoulder joint is closely connected with the emotions, pleasure being exemplified by the outstretched hand and repugnance by drawing the arm in to the side. Limited active abduction at the shoulder is therefore not uncommonly a withdrawal phenomenon in conversion hysteria. But the patient does not realise that, unless the scapula is also fixed, mobility of this bone permits considerable abduction. Even in ankylosis at the shoulder joint, 60° of movement of the arm away from the side are possible, actively and passively, owing to scapular rotation. Hence detection of psychogenesis is simple if the range of voluntary and passive elevation is contrasted with the range of passive abduction at the scapulo-humeral joint. In organic disability, the range of passive elevation equals the passive scapulo-humeral range plus 60°.

The large number of patients who have carried off this psychogenic conversion undetected, and have in consequence enjoyed years of treatment, testifies afresh to the diagnostic importance of comparing the responses to active, passive and resisted movements.

TENDINOUS LESIONS

These are common at the shoulder, but it is by no means enough merely to call them rotator cuff lesions. Which member of the cuff, and what part of it, must be discovered. Two criteria must be satisfied before a diagnosis of a tendinous lesion can be made: (1) There must be a full range of passive movement at the shoulder joint. However, there is nothing inconsistent in pain being evoked by stretch or pinch at one extreme. (2) Pain must be evoked when one group of muscles

is tested against resistance, but there must be no pain when all the other groups are similarly tested. Accessory tests then serve to show which member of the muscle group contains the lesion and, often, which part of it. If all the resisted movements are found painful, the conclusion is drawn that the muscles are unaffected and that the pattern formed by the passive movements should be studied afresh; alternatively, the lesion lies at a joint proximal to that under examination.

1. Resisted Abduction Hurts

The patient's arm hangs by his side and the examiner resists the attempted abduction by pressing so hard against his elbow that no movement takes place at the shoulder joint. If this endeavour causes pain (and the other resisted movements do not hurt) the supraspinatus tendon is at fault. In theory, the deltoid muscle might be the source of pain evoked in this way, but in my experience lesions of the deltoid other than a direct temporary bruising do not occur.

The position of the lesion within the supraspinatus tendon is then identified as follows (see Fig. 1).

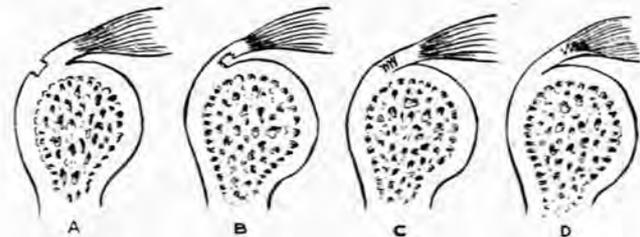


Fig. 1. Supraspinatus tendinitis. Accessory signs indicate the exact position of the lesion.

A. Painful arc. The lesion superficially at the teno-periosteal junction.

B. Pain on full passive elevation. The lesion lies deeply at the teno-periosteal junction.

C. Both a painful arc and pain on full passive elevation. The lesion traverses the distal end of the tendon.

D. Neither an arc nor pain on full passive elevation. The lesion lies at the musculo-tendinous junction.

(a) *A Painful Arc Exists.* This shows the lesion to lie where it can be pinched between acromion and greater tuberosity, i.e. superficially near teno-periosteal junction, just medial to the greater tuberosity of the humerus. Should the painful arc prove more marked when the abduction movement is carried out in medial than in lateral rotation of the arm (i.e. palm down or palm up) additional information is afforded. Greater pain when the arm is held in lateral rotation (palm up) suggests that the lesion in the tendon lies anteriorly. Of course, the mere presence of a painful arc exculpates the deltoid muscle.

(b) *Full Passive Elevation of the Arm Hurts.* This implies tenderness of the part of the tendon which engages against the glenoid rim; i.e. the deep aspect at the teno-periosteal junction. If this sign is found together with a painful arc, the lesion clearly traverses the distal end of the whole tendon.

(c) *The Absence of a Painful Arc* and of pain elicited on full passive elevation naturally suggests a lesion of the supraspinatus at the musculo-tendinous junction, since the belly itself is very rarely affected. Tenderness of the musculo-tendinous junction may be sought, and the two sides com-

pared, deeply within the angle formed by the clavicle and the spine of the scapula. However, local anaesthesia should always be used to verify this diagnosis; for an occasional case of tendinitis at the teno-periosteal junction unexpectedly fails to show either of the two localising signs.

In spite of the intimate relation of the supraspinatus tendon and the subdeltoid bursa, a resisted abduction movement, when properly tested (i.e. without any movement taking place between humerus and acromion), is painless in even acute bursitis.

2. Resisted Lateral Rotation Hurts

When a patient is asked to rotate his arm laterally against resistance, he usually abducts his arm at the same time, thus exerting both spinatus muscles. To guard against this, he must be asked to hold his elbow well into his side while pressing his lower forearm outwards against the examiner's resistance. If this endeavour causes pain, the infraspinatus tendon is at fault.

The same accessory tests are then employed as in supraspinatus tendinitis, in order to reveal which part of the tendon is affected. Pain on full passive elevation incriminates the deep aspect and a painful arc the superficial aspect of the teno-periosteal junction.

3. Resisted Medial Rotation Hurts

This movement elicits pain from lesions of subscapularis, pectoralis major, latissimus dorsi and teres major muscles. The last-named three muscles are all adductors, whereas the subscapularis muscle is not. It suffices, therefore, to show the absence of pain on a resisted adduction movement to demonstrate that the subscapularis is the muscle affected. If a lesion of this muscle has thus been shown to exist, two further localizing signs should be sought. (1) A painful arc. If this is present the lesion can be confidently ascribed to the uppermost part of the teno-periosteal junction, since only the top of the lesser tuberosity can engage against the coraco-acromial arch. (2) Pain on passive adduction across the front of the chest. At the extreme of this movement the lesser tuberosity is squeezed against the coracoid process. This shows the lesion in the tendon to lie in its humeral insertion at its lower extent.

4. Resisted Adduction Hurts

The arm is brought a short distance away from the body and the adduction movement resisted by pressure exerted against the inner side of the elbow. The muscles responsible are the pectoralis major, the latissimus dorsi and the two teres. Pain, except when it arises from the axillary portions of the pectoralis major or latissimus dorsal muscles, is usually correctly appreciated by the patient at the anterior or posterolateral aspects of the thorax respectively. When the patient's sensations are no guide and an adduction movement hurts, the next part of the examination is to ask him to swing his arm first forwards then backwards against resistance. If the former hurts, the pectoral muscle is at fault and confirmation may be sought by asking him to press his hands together. If the backward movement hurts, the fault lies in one of the other three muscles. The teres muscles may be differentiated by the fact that the major is a medial, the minor

a lateral, rotator of the humerus. The latissimus dorsi and teres major muscles being identical in function, no test distinguishes between them.

Palpation follows when the pectoralis major muscle is affected, the fibres just below the lateral half of the clavicle or those at the lower extent of the outer edge being the common sites. The lesion in the latissimus dorsi muscle is usually found at the upper part of the outer edge.

5. Resisted Flexion and Supination of the Elbow Hurt

If the pain is felt at the shoulder, the long head of biceps is at fault. Unless, as is rare, a painful arc exists, no localizing sign is to be found. Hence the tendon has to be palpated along the whole of its extent in the bicipital groove.

PAINFUL ARC

The presence of a painful arc as the arm passes the horizontal on its way up to full elevation means that a tender structure is squeezed as the greater tuberosity of the humerus passes under the acromion and the coraco-acromial ligament.

A painful arc is therefore present in supraspinatus tendinitis and a particularly marked arc suggests calcification in the tendon, in infraspinatus tendinitis and in subscapular tendinitis, provided that the lesion lies at the pinchable part of the tendon. It also occurs if the inferior aspect of the acromio-clavicular joint is affected and in most cases of subdeltoid bursitis.

Chronic Subdeltoid Bursitis

This comes on insidiously for no apparent reason and often continues indefinitely. As a rule the radiograph reveals nothing.

The pain is felt at the deltoid area only and clinical examination reveals a painful arc and nothing else. Neither the extreme of any passive movement nor any resisted movement hurts. Localized tenderness must be sought, but this is difficult to assess since the bursa is normally rather tender to deep pressure. Moreover, the affected area may lie under the acromion out of fingers' reach. The only way to be sure that the right spot has been found is to induce local anaesthesia with 5 c.c. of 0.5% procaine. Five minutes later the shoulder is examined again to discover whether or not the arc has disappeared. It so happens that local infiltration is also the effective method of treatment; the injection thus serves a double purpose.

Incomprehensible Pattern. A pattern may emerge that appears self-contradictory. A full range of movement is found present, usually with a painful arc, but when the resisted movements are tested they hurt and when tested again do not hurt, in an erratic manner. This shifting pattern of resisted movements occurs in chronic subdeltoid bursitis. Another misleading pattern is provided by pain on both resisted abduction and resisted lateral rotation, again together with full range and a painful arc. Sometimes this combination means that both tendons are affected; at others, subdeltoid bursitis. The only way to find out is the induction of local anaesthesia repeated if necessary till the right spot is found.

MUSCLE WEAKNESS

The resisted movement is found weak, but does not bring on or increase the pain. This implies a nerve lesion or complete rupture of the tendon. The possibilities are:

1. *Weak Deltoid Muscle.* An axillary nerve palsy is the result of over-stretching the nerve. This is apt to follow a dislocation of the head of the humerus, which may be momentary, with the result that the typical history of dislocation and reduction is not reported. The deltoid muscle remains weak and wasted, until spontaneous recovery is established in 6-12 months.

2. *Powerless Supraspinatus Muscle.* This results from rupture of the tendon. The patient cannot abduct his arm voluntarily from his side, since the deltoid muscle merely pulls the head of the humerus upwards into the gap formed by the absent supraspinatus tendon, where it becomes fixed.

Passive abduction meets a marked painful arc at the horizontal. Once this point is passed, the patient finds to his surprise that he can elevate his arm actively to the vertical without difficulty.

3. *Powerless Lateral Rotator Muscles.* The tendons of the infraspinatus and teres minor muscles appear to rupture together, since full lateral rotation becomes impossible, even actively, without resistance. The lesion is rare and the patient is little concerned; except in heavy workers the disablement is minimal.

As a result of never laterally rotating the arm, anterior capsular contracture from disuse sets in painlessly in the course of the next year or two, permanently limiting that range.

4. *Weak Supraspinatus and Infraspinatus Muscles.* This is the result of neuritis of the suprascapular nerve. The symptoms are continuous pain in one scapular area, unaltered day or night or by any movement of the neck, scapula or arm. The pain eases spontaneously in 2-3 weeks, but the muscle palsy may take 6 months to recover.

5. *Weak Deltoid, Spinati and Biceps Muscles.* This indicates a fifth cervical root palsy, very probably the result of a fourth cervical disc lesion. The biceps jerk is usually sluggish or absent and the brachioradialis jerk absent or inverted.

6. *Weak Serratus Anterior Muscle.* This is caused by a long thoracic neuritis. The patient may have a fortnight's continuous pain in the scapular area, but at times the palsy appears without any preliminary symptoms. Examination shows that the patient has lost the last 30° to 40° of active elevation, but that there is no bar to full passive elevation. When the muscles about the shoulder are tested, all are found strong; it follows that the defect lies in active rotation of the scapula. When the patient is asked to bring his arm forward to the horizontal and press his hand against the wall, winging of one scapula becomes obvious. Spontaneous recovery in the course of 4-8 months is the rule.

SUMMARY

The shoulder is examined by testing active, passive and resisted movements. The diagnosis is arrived at by correlating these clinical findings and interpreting the pattern that emerges on a basis of applied anatomy.

The illustration is taken from volume I of my *Text-book of Orthopaedic Medicine*, published by Cassell.