Tenderness at motor points: An aid in the diagnosis of pain in the shoulder referred from the cervical spine

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Cervical spondylosis, a universal degenerative condition, often is misdiagnosed, because it causes no symptoms unless it impinges on pain-sensitive tissues or a nerve root to cause radiculitis and consequently is difficult to detect in early stages. It is possible to recognize neuropathy, however, by the presence of tenderness at motor points, since spondylotic pain may be transmitted via the segmental nerve to the corresponding myotome and felt as muscle pain and tenderness, which may be elicited easily at the motor point. In a combination prospective/retrospective study of 407 patients with primary shoulder pain, 50 patients who showed no obvious physical signs required electromyography for definitive diagnosis. Observations of tender motor points in these patients are compared with the medical records of the remaining 357 patients. Tender motor points were always found in patients with cervical spondylosis and shoulder pain, but absent in patients with extrinsic shoulder pain unless accompanied by concurrent spondylosis.

Shoulder pain frequently is confusing because it may be due to local lesions in the shoulder or it may be referred from some other area (Tables 1 and 2). The most common causes of pain in the shoulder are cervical spondylosis (referred) and rotator cuff tendinitis[1] (local).

Although it is recognized that shoulder pain may emanate from the cervical spine, such pain often is misdiagnosed. Indeed, pain in the shoulder may be the only presenting symptom of degeneration of a cervical disk, since the presenting symptom of lesions in the cervical spine usually is not pain in the neck but pain in the shoulder region.

The three common types of lesions in the cervical spine that may lead to referred shoulder pain are:

(1) protrusion of an intervertebral disk;

(2) spondylosis secondary to disk protrusion; and

(3) diffuse primary spondylosis, with degenerative changes affecting the joints between the vertebral bodies as well as the posterior joints between the articular processes. These changes frequently are not only severe but widespread, and only exceptionally are protrusions of intervertebral disks present.

Spondylosis, whether primary or secondary, may occur with or without irritation and compression of the nerve root, that is, "radiculitis," a clinical term commonly used to describe discomfort or pain radiating along the peripheral nerve. When radiculitis is present, the cervical spondylosis normally is easily recognized, since the referred pain is sharp and well localized, with paresthesia and numbness in the sensory distribution of the root. There may be muscular fasciculation, cramp, or weakness in the motor distribution, and tendon reflexes may be depressed. However, when cervical neuropathy is mild, the referred pain is vague and the clinical signs sparse. The perplexing clinical picture may lead the examiner to dignify the shoulder pain with a variety of labels devoid of physiologic significance. Then treatment, based on faulty pathomechanical concepts, inevitably will fail.[2]

The problem is complicated further when roentgenograms are taken, since these may lead to diagnostic errors based on the misinterpretation of radiologic appearances. The capsule of the shoulder joint, the bursae, and the tendons all are radiotranslucent; hence, the radiograph of a painful shoulder usually reveals no abnormality. Moreover, since most patients with a painful shoulder are middle aged, the radiologic picture of a narrow joint space or degenerative changes, which may be irrelevant, generally are found. The temptation to treat the

roentgenogram rather than the patient should be resisted.

Whether pain at the shoulder results from a local lesion or is referred can be determined only by clinical examination. Preferably, referred pain to the shoulder should be excluded before detailed examination of the shoulder is undertaken.[3] Whilst there are many good descriptions of examination of the shoulder for local lesions,[1-4] however, there is no simple method of examination for early referred cervical pain. It is the purpose of this paper to present our approach to the problem and describe some salient features by which neck-derived pain may be recognized. Our examination is based principally on the presence of tenderness at motor points (where the motor nerve enters the muscle) in affected myotomes and is comparable to our examinations for low-back pain[5] and referred pain to the elbow.[6] A series of 50 patients with no obvious abnormality of the shoulder were studied, and electromyographic and radiologic data on them are presented in Table 3. Electromyography is the most sensitive, if not the only, means of reliable diagnosis of early spondylosis.

TABLE 1. LOCAL CAUSES OF SHOULDER PAIN.

Neoplasms of shoulder girdle
Osteomyelitis
Avascular necrosis of head of humerus
Arthritis of glenohumeral joint:
rheumatoid
metabolic
infective
of acromioclavicular joint:
degenerative
"Shoulder girdle neuritis" due to
neuralgic amyotrophy
serratus anterior palsy
entrapment of suprascapular nerve
Rotator cuff tendinitis

TABLE 2. CAUSES OF REFERRED PAIN TO THE SHOULDER.

Thalamic pain
Thoracic outlet syndromes
Apical lung tumors
Mediastinal lesions
Diaphragmatic irritation
Cervical spondylosis
(with and without root irritation)

Materials and methods

The study was in part prospective and in part retrospective.

In the 14 months from November 1, 1974, through January 1, 1976, out of a total of 407 patients referred by attending physicians to the Rehabilitation Clinic of the Workers' Compensation Board of British Columbia for primary shoulder pain, there were 50 who showed no obvious physical signs and required electromyography for definitive diagnosis of pain from the neck (Group C, prospective). The observations of tender motor points in these 50 patients are compared with those of the remaining 357 patients (Groups A and B, retrospective, from medical records).

On admission, the history taking and clinical examination were directed first to localizing the source of pain. The examination was divided into two parts, the first part a search for referred pain by a routine to be described hereafter and the second for local lesions by standard methods of examination.

The examination for referred pain was based on an awareness of the following characteristics of early neuropathy. In referred pain, the patient usually complains of a vague nagging and persistent pain outlined in a broad and diffuse manner over the area between the neck and shoulder, whereas a patient suffering from a shoulder lesion demonstrates the site of pain by placing his hand over the deltoid muscle.[1] Pain referred from the cervical spine to the shoulder sometimes but not always may be reproduced or modified by movement of the cervical spine, but shoulder pain from intrinsic causes almost always is reproduced by movement of the shoulder.

With referred pain, the shoulder joint generally retains a full range of motion, but the cervical spine when carefully assessed may reveal slight limitation or resistance to lateral rotation or lateral tilting (usually to the painful side), although casual examination

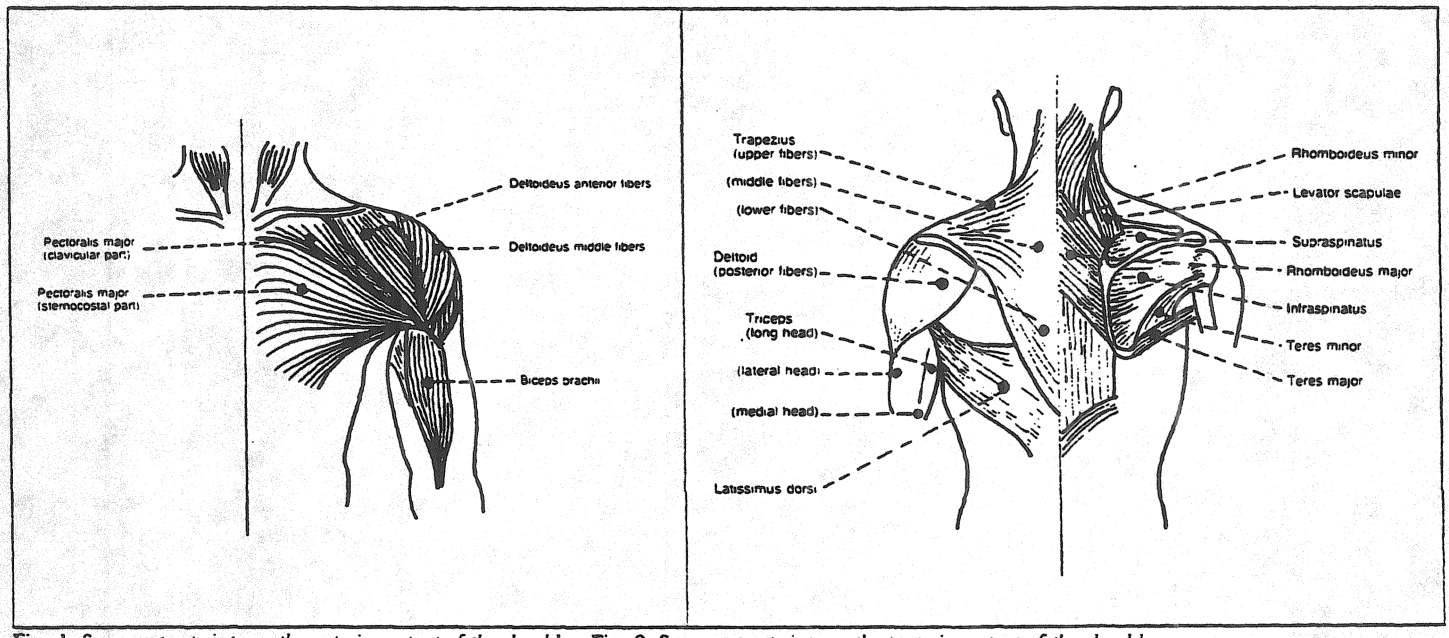

Fig. 1. *Some motor points on the anterior aspect of the shoulder.* Fig. 2. *Some motor points on the posterior aspect of the shoulder.*

may show good range of motion. At affected levels, the cervical nerves as they emerge from the pain-sensitive capsular tissues around the apophyseal joints[7] and the deep neck muscles (supplied by the posterior primary rami) are always exquisitely tender to digital pressure (commonly at C5 and C6). To sensitive fingers, the apophyseal joints may show resistance to passive motion.[8]

Cervical neuropathy is reflected in sensory, motor, and autonomic signs.[4,6] Superficial sensory changes may occur in affected dermatomes, but, because of dermatomal overlapping, may be difficult to delineate accurately. In early neuropathy, clinical testing of muscle power shows no gross weakness, but there may be perceptible atrophy. (Commonly, the supraspinatus and infraspinatus show slight flattening, and the triceps is flabby.) Fasciculation is rare. Tendon reflexes become depressed only in late stages. Autonomic instability, when present, may be apparent immediately when the patient undresses, with the cold air falling on exposed skin producing a pilomotor effect or cutis anserina (goose pimples) in affected dermatomes.[6] Vasomotor manifestations of poor circulation sometimes may be observed, with the painful site slightly colder to touch than surrounding tissue.

We have found that early neuropathy may be elicited best by palpating for tender motor points, what Richardson[9] called "myalgic spots." These occur in affected myotomes (to be discussed). For this examination, a knowledge of the locations of motor points in the shoulder and upper limbs is essential (Figs. 1, 2). Motor points have been used for years for electrical stimulation of innervated muscles and are known

TABLE 3. TENDER MOTOR POINTS IN 50 PATIENTS WITH REFERRED SHOULDER PAIN.

Patient no.	Patient	Age, Sex	Diagnosis on referral	Location of tender motor points*											Tender apophyseal joints†	Roentgenograms of cervical spine	Roentgenograms of shoulder	EMG data, nerve root
				Tz	Ss	Is	D	Ls	P	Bi	Ext	Sup	Tri	Fc	Apb				
1	G.D.	29, M	Contusion to shoulder	1	1	1	2				1	1		1	3	C6-7	Normal	Normal	Mild neuropathy C7-8
2	G.K.	24, M	Fall on shoulder	2	2	1			2							C5-6	Normal	Normal	Slight fall of amplitude and frequency C6
3	P.S.	46, M	Pull on shoulder		3	2	3		3							C5-6	Degeneration C5-6	Normal	Moderate neuropathy C5-6
4	A.W.	44, F	Contusion to shoulder and elbow	2	2	2	2				2	2		2		C4-6	Slight limitation of motion C5-7	Normal	Mild neuropathy C4-6
5	R.P.	48, M	Pulled shoulder				3						3			C3-7	Severe narrowing C3-7	Normal	Moderate neuropathy C4-7
6	A.P.	64, M	Fall on shoulder	2	3		3				3	2				C4-6	Mild degeneration with slight narrowing C5-6	Normal	Moderate neuropathy C4-6
7	R.S.J.	32, M	Acute shoulder and arm strain	3	3	2	2		3		3	3			1	C3-6	Normal	Normal	Moderate neuropathy C3-4 and 7
8	U.L.	33, F	Acute shoulder strain	2	2	2	2				2	2		2		C5-6	Normal	Normal	Mild neuropathy C5-6
9	C.C.	36, M	Acute shoulder strain	3	3	3	3			3	2	2				C4-6	Normal	Normal	Moderate neuropathy C4-6
10	P.E.	34, M	Struck on shoulder	3	3		3		2							C4-5	Slight roto-scoliosis	Normal	Moderate neuropathy C4-6
11	L.F.E.	36, F	Shoulder strain (musculo-ligamentous)	3	1		3		3	1						C3	Slight degeneration C2-3, with encroachment into foramina	Normal	Moderate neuropathy C4
12	A.G.	54, M	Fall on shoulder	2					2	2	2			2		C5-7	Limitation of motion C5-7	Normal	Mild neuropathy C6-8
13	A.S.	56, M	Fall, striking shoulder	2	3	3	3		3	2	2	2				C5-6	Degenerative changes, narrowing C4-5; slight encroachment into foramina	Normal	Mild neuropathy C4-6
14	D.A.J.	21, M	Fall against scapula		2	2	2		2		2	2			2	C4-7	Degenerative changes C6-8; myelogram shows slight defect C6-7	Normal	Mild neuropathy C5-7
15	E.F.	47, M	Shoulder and neck strain	3							2	2				C4-6	Degeneration, slight narrowing C5-6-7	Normal	Moderate neuropathy C4-6

16	C.G.	42, F	Acute shoulder strain	3	3	2	3	2		2	2	C4-5	Normal	Normal	Moderate neuropathy C4-5
17	A.B.	49, M	Pulled shoulder, acute	2	2		2			2		C4-5	Normal	Normal	Mild neuropathy C4-5
18	G.B.	46, M	Hyperextension strain of shoulder	3	3		3					C5-6	Advanced degeneration C4-7	Normal	Mild to moderate neuropathy C4-5-6
19	D.O.S.	66, M	Bursitis from contusion	3	3	2	3			3	3	C5-6	Limitation of motion C4-5, with slight narrowing C5-6, osteophytes	Roughening of humeral head; degenerative lipping of glenoid	Moderate neuropathy C5-6
20	F.D.	28, M	Struck on back of shoulder, neck					3	3	3	3	C5-7	Limitation of motion C5-7	Normal	Moderate neuropathy C5-6-7
21	L.S.	30, M	Bicipital tendinitis	3	2	2	3			3	3	C4-6	Limitation of motion C5-6; slight narrowing C5-6	Normal	Moderate neuropathy C4-5-6
22	M.B.	46, F	Pulled shoulder, neck strain	3				3		3	3	C5-6	Moderate degeneration C5-6; narrowing	Normal	Moderate neuropathy C5-6
23	O.G.F.	31, M	Fall, Soft tissue injury of neck, shoulder	3	2		2	2				C5-6	Normal	Normal	Mild neuropathy C5-6-7
24	M.S.	36, M	Fall on shoulder, cervical strain				2	2	2	2	2	C4-5-6	Normal	Normal	Mild neuropathy C5-6-7
25	A.B.	44, F	Acute contusion, hemarthrosis of shoulder joint	3	3		3	3	2			C5-6	Normal	Normal	Moderate neuropathy C5-6-7
26	J.S.	54, F	Bicipital tendinitis	3			3	3	2			C5-7	Advanced degeneration C5-7; slight narrowing, encroachment into foramina	Normal	Moderate neuropathy C5-6-7

*$\overline{Tz}$ = Trapezius; Ss = Supraspinatus; Is = Infraspinatus; D = Deltoideus; Ls = Levator scapulae; P = Pectoralis major; Bi = Biceps brachii; Ext = Common origin of wrist extensor; Sup = Supinator; Tri = Triceps; Fc = Flexor carpi ulnaris; Apb = Adductor pollicis brevis. Tenderness graded 1-3 (see text)

†The tenderness elicited is probably present in the surrounding capsular tissue.[7] Lesser degrees of tenderness may be present in the joints above and below those listed.

(Table 3 continued)

(Table 3 continued)

27	G.W.	55, M	Arm and neck strain	1	1	1	3		3	1	1				C4-5	Degeneration and narrowing C5-6	Normal	Moderate neuropathy C5-6
28	D.H.	30, F	Shoulder pain, cervical strain	2	2		2		2	2		2			C4-5-6	Normal	Normal	Mild neuropathy C5-6-7
29	M.W.	36, F	Shoulder pain, tennis elbow	2	2		2	2		2	2	2	2	2	C4-7	Normal	Normal	Mild neuropathy C4-5-6-7
30	M.J.	30, F	Acute shoulder and neck strain	2	2	2	2	2							C3-6	Normal	Normal	Mild neuropathy C5-6
31	M.M.	51, M	Contusion of shoulder, bursitis	3	3	3	3		2						C4-6	Degeneration C5-6	Normal	Moderate neuropathy C5-6
32	E.M.	45, M	Contusion and fall on shoulder	2	2	2					2	2			C5-6	Normal	Normal	Mild neuropathy C4-6
33	D.R.	28, M	Arm and shoulder pain	2	2					3			2		C2-6	Normal	Normal	Mild neuropathy C5-7
34	P.T.	39, M	Tennis elbow, shoulder pain	3	3					3					C5-6	Advanced degeneration C5-7	Normal	Moderate neuropathy C5-7
35	F.E.	33, M	Cuff tear; bicipital tendinitis	2	2		2	2							C3-4	Normal	Normal	Mild neuropathy C4-5
36	I.M.	51, F	Tennis elbow, shoulder pain		2					3		2	2		C5-6	Normal	Normal	Mild neuropathy C5-7
37	B.L.	35, M	Bicipital tendinitis	2	2		2		2	2	2		2		C4-6	Normal	Normal	Mild neuropathy C5-7
38	P.S.	48, M	Shoulder strain				3		3	3	3				C6-7	Narrowing C6-7; osteoarthritis, encroachment into foramina	Normal	Moderate neuropathy C6-7
39	L.R.	53, M	Fall, shoulder contusion	2	2					2	2		2		C4-6	Normal	Normal	Mild neuropathy C4-7
40	C.R.T.	65, M	Arthritis	2	2		2		2	2					C4-6	Slight degenerative changes C4-6	Minor degenerative changes	Mild neuropathy C4-7
41	E.A.	46, M	Neck and shoulder strain	3	3		3			3				2	C4-6	Degenerative changes C5-6; minimal osteophyte encroachment	Normal	Moderate neuropathy C5-6-7

42	D.W.	24, F	Pain in levator scapulae, shoulder; cervical strain from fall	2	2	2	2	2		2	2	2			C5-6	Normal	Normal	Mild neuropathy C5-6
43	A.W.	62, M	Bicipital tendinitis	2	2		3		3				2		C5-6	Degeneration and narrowing C4-6	Normal	Moderate neuropathy C5-6
44	R.M.	50, M	Muscular pain in left arm, shoulder, possible cardiac pain	3					3		2	2	2		C3-6	Normal	Normal	Moderate neuropathy C4-6 (ECG normal)
45	W.A.K.	48, M	Pericapsulitis of shoulder		3		3				3	3			C5-7	Mild degeneration C5-6	Normal	Moderate neuropathy C5-7
46	R.M.	51, M	Cervical strain		2	2	3			2					C5-6	Minor degeneration C5-6	Normal	Moderate neuropathy C6-7
47	L.B.	25, M	Muscular strain	1	2		2			3	3	3			C5-6	Normal	Normal	Moderate neuropathy C6
48	J.S.	38, M	Contusion of neck, shoulder	3	3										C5-7	Minor degeneration C4-5	Normal	Denervation C6-7-8
49	A.M.	33, M	Shoulder and elbow pain from neck		3	3			3						C4-5	Rotoscoliosis, limitation of motion C4-5	Normal	Slight denervation C5-6-7
50	R.R.H.	40, M	Neck strain, shoulder pain	3	3		3	3	3						C4-6	Normal	Normal	Slight denervation C4-6

to any physiotherapist.[10,11] Chusid[12] has provided charts showing their locations. In our study, the tender "myalgic spots" were confirmed as motor points by the evocation of muscle twitches in response to minimal electrical stimulation with a calibration-stable stimulator with variable control of output, but since motor points are fixed anatomic sites and vary only slightly from person to person, the use of a stimulator is not imperative.

To palpate for tenderness, firm digital pressure is required to compress the neurovascular hilus strongly against underlying bone. In the present study, the tenderness observed was graded as in our previous study,[5] as follows:

Grade 0: No tenderness whatsoever to firm digital pressure;

Grade 1: Patient aware of some tenderness, which is not unpleasant;

Grade 2: Tenderness moderate or unpleasant;

Grade 3: Tenderness acute, so the patient often is surprised and reacts vigorously.

Pressure eliciting tenderness of Grades 2 and 3 occasionally may induce autonomic reactions—a pilomotor effect in affected dermatomes and profuse sweating or a sudomotor effect in the axillae or hands.[6]

Roentgenograms of the shoulder and cervical spine (including lateral views in flexion and extension and anteroposterior, open-mouth, and oblique views) were taken of the 357 patients of Groups A and B as indicated, but roentgenograms and electromyographic studies were made of all 50 Group C patients (Table 3). Radiologic changes in the cervical spine were regarded as mild when there were early degenerative changes with or without evidence of restriction of motion in lateral views in flexion or extension. They were considered to be moderate or severe when there was moderate or advanced osteoarthrosis or narrowing of disk spaces with osteophyte encroachment into the intervertebral foramina.

In electromyography, the representative muscles of C3-D1 myotomes were examined immediately after palpation.

Table 4 shows the root derivations of motor nerves supplying some muscles of the arm and shoulder. Most muscles receive their innervation from more than one segment of the spinal cord, as indicated in this Table. The segments listed are those generally accepted as the predominant sources of innervation of the muscles in question, all of which are innervated by the anterior rami whose fibers pass along the nerves indicated on the right. The posterior rami from these same cord segments supply skin and muscles of the back of the neck (semispinalis capitis and cervicis and splenius capitis and cervicis). According to Buchthal and Pinelli,[13] signs of neuropathy include increased needle insertional activity and a relative increase of mechanically induced discharge of action potentials by electrode movement. With voluntary contraction, the mean duration of action potentials is prolonged, but amplitude may be normal or reduced. Typically, polyphasic potentials appear in abnormal numbers; the interference pattern is reduced or in severe conditions lost altogether, and the action potentials of individual units can be identified even during maximal contraction. These abnormalities, typical of neuropathy, usually are not obvious, according to Goodgold and Eberstein,[11] but appear as subtle changes from the normal state. Fasciculation potentials, positive sharp waves, and fibrillation potentials develop only when denervation is present. Those authors stated that the occurrence of fibrillation should not be accepted as the only criterion for establishing the diagnosis of neuropathy. Fibrillation potentials arrive late if at all.[11] In all patients with a history of acroparesthesia or a suspicion of carpal tunnel syndrome or ulnar tardiness, conduction velocity tests of motor nerves were done.

Results

The 407 patients seen fell into three main groups:

Group A

Group A, patients with intrinsic shoulder lesions, made up 331 of the 407, or 81.3 percent. With these there was no difficulty in diagnosis. They were recognized clinically by the admitting physician as

TABLE 4. SPINAL CORD ROOT DERIVATIONS OF MOTOR NERVES SUPPLYING SOME ARM AND SHOULDER MUSCLES.

Muscle	Root innervation	Peripheral nerve
Trapezius (upper)	C3-4	Spinal accessory
Levator scapulae	C3-4-5	C3-4, dorsal scapular
Supraspinatus	C5-6	Suprascapular
Infraspinatus	C5	Suprascapular
Deltoideus	C5-6	Axillary
Biceps brachii	C5-6	Musculocutaneous
Pectoralis major	C5-6	Anterior thoracic
Supinator	C5-6	Radial
Extensor carpi radialis	C5-6-7	Radial
Extensor carpi ulnaris	C6-7-8	Radial
Extensor digitorum communis	C6-7-8	Radial
Triceps brachii	C6-7-8	Radial
Flexor carpi ulnaris	C7-8, D1	Ulnar
Adductor pollicis brevis	C8, D1	Ulnar

TABLE 5. OBSERVATIONS IN 90 PATIENTS WITH ROTATOR CUFF INJURIES.

Diagnosis	No. of patients	Age	Sex	Limitation of shoulder motion	Pain arc	Roentgenograms of shoulder
Tendinitis	86	21-66, average 44.9	M, 80 F, 6	In all but 6	46	Degenerative changes in 14 of 72 patients (19.4%); calcific deposits in 15 (20.8%); normal, 43 (59.7%)
Complete rupture	3	54-60, average 56.6	M, 3 F, 0	In all 3		Normal in 2, slight degenerative changes in 1
Avulsion of cuff insertion	1	29	M	In 1		Avulsion of bony tuberosity

having lesions intrinsic to the shoulder. All patients had symptoms and signs referable to the shoulder, such as a painful arc of movement, localized tenderness over the lesion, and limitation of joint motion, with or without disruption of the scapulohumeral rhythm. Radiologic changes in the shoulder were present in some. A small number (23 of 331) had tenderness at motor points.* In this small group there was also slight loss of motion or tenderness in the cervical spine, and the cervical roentgenograms almost invariably revealed evidence of degenerative changes at levels corresponding to the myotomes where the tender motor points were elicited in both anterior and posterior rami. Late neurologic signs such as depression of tendon reflexes were absent.

Table 5 lists the observations in 90 patients with rotator cuff injuries.

Damage to the rotator cuff varies from the tear of a few fibers in the substance of the tendon to tears involving the full thickness of the cuff. Predisposing factors are the degenerative changes in the shoulder joint ("degenerative periarthritis") occurring with age, and many patients showed the sequelae of attrition in both cuff and biceps tendon.

"Tendinitis" affected 86 patients. With this there was a full range of passive movements with pain at the extremes. Usually there was pain and weakness on resisted movements—resisted abduction in the supraspinatus muscle, resisted lateral rotation in the infraspinatus, resisted lateral rotation and adduction in the teres minor, or resisted medial rotation in the subscapularis. Resisted adduction seldom hurts. A painful arc (indicating tenderness of tissue between the tuberosities and the acromion) also was seen in 46 of 86 patients (53.5 percent). Since the shoulder joint itself usually is involved to some extent after trauma when degenerative periarthritis is present, limitation of shoulder joint motion in a capsular pattern[3,8] occurred in most patients (80 of 86, or 93.0 percent). There was a little limitation of medial rotation, some limitation of abduction, and considerable limitation in lateral rotation. Night pain was a common feature. Tenderness over the cuff was present in almost all patients and calcified deposits were seen in 15 patients (17.4 percent). In 14 of 86, or 16.3 percent, both cuff and biceps tendon were affected.

Three patients suffered complete rupture, with severe pain and inability to abduct the arm. These patients were past 50, and their roentgenograms showed no fracture or dislocation. Surgical repairs were necessary.

One patient suffered avulsion of the cuff insertion. The patient was 29 years old, with a presumably healthy cuff that did not rupture. The discontinuity occurred as an avulsion of the bony tuberosity and required surgical repair.

*This figure, taken from our medical records, is probably low, since there was a variable period before newly recruited medical staff acquired the palpation technique.

Tender motor points were elicited in 10 of the 90 patients (11.1 percent). In 9 of these 10 patients, roentgenograms of the cervical spine showed radiologic evidence of spondylosis. All had tenderness in the neck or some restriction of movement of the cervical spine at levels corresponding to the myotomes within which tender motor points were found.

There were five patients with subdeltoid bursitis (Table 6). This seldom is a primary condition. Usually it is secondary to degenerative lesions of the cuff. Examination of these patients showed either a painful arc alone (indicating that tissue lying between one of the tuberosities and the acromion is tender) or a painful arc with discomfort at the extremes of passive range but without pain on resisted movements.

Tender motor points were present in only 1 patient, whose cervical spine showed slight limitation of lateral rotation. Cervical roentgenograms showed degenerative changes at affected levels.

Twelve patients had adhesive capsulitis, or "frozen shoulder" (Table 7). This syndrome, a clinical but not a pathologic entity, refers to the stiff shoulder in which active and passive movement is restricted and painful at the glenohumeral joint as well as at the scapulothoracic joint. It is without demonstrable intrinsic cause. There is no osseous ankylosis, and usually its duration is self-limited.[1,3,8]

Tender motor points were elicited in 1 patient, in whom there were tenderness and slight limitation of movements of the cervical spine. There was radiologic evidence of cervical spondylosis at levels corresponding to myotomes within which the tender motor points were elicited.

Forty-two patients suffered from contusions (Table 8). In 3 of these (7.1 percent) there were tender motor points, and these also showed tenderness and slight limitation of motion of the cervical spine at corresponding levels. Their roentgenograms showed evidence of spondylotic changes at segmental levels corresponding to myotomes within which tender motor points were elicited.

Table 9 lists the data on 44 patients with bicipital syndromes. The clinical lesions involving the long head of the biceps are tendinitis and tenosynovitis; ruptures, partial or complete; recurrent subluxation/dislocation; and elongation.

Most of the patients in this group had the supination sign described by Yergason.[14] This sign is elicited with the elbow flexed to 90 degrees and the forearm pronated. The examiner holds the patient's wrist to resist supination and then instructs the patient to attempt supination against resistance. The sign is present if this causes pain definitely localized in the bicipital groove.

Of 39 patients with tendinitis or tenosynovitis, only 4 showed tender motor points, and these also showed slight limitation of movements of the cervical spine. Cervical roentgenograms of 3 of these showed evidence of spondylosis. No tender motor points were found in 5 patients with rupture.

There were 14 patients who had had anterior or anterior-inferior dislocations (Table 10). Surgical repair was done in 3 for recurrent dislocation. No tender motor points were found.

Seven patients had fracture dislocation (Table 11). Tender motor points were elicited in only 1, who also had tenderness and slight limitation of movements of the cervical spine. Roentgenograms of the cervical spine showed narrowing at C5-C6, the levels corresponding to myotomes within which tender motor points were elicited.

In 16 patients pain followed fracture of the humerus or scapula (Table 12). Included were fractures of the greater or lesser tuberosity of the humerus or the anatomic and surgical necks, the glenoid fossa or neck of the scapula, the acromion, and the coracoid process. No tender motor points were found.

For 65 patients, diagnosis of a nonspecific "sprain" of the shoulder was made (Table 13). These generally were patients less than 50 years old (average age, 35.3 years), compared with those who suffered

TABLE 6. DATA ON PATIENTS WITH BURSITIS.

No. of patients	Age	Sex	Local tenderness	Pain arc	X-ray picture of shoulder
5	28-60, average 48.2	M, 3 F, 2	5	5	Normal in 4; calcification in 1

TABLE 7. DATA ON PATIENTS WITH "FROZEN SHOULDER."

No. of patients	Age	Sex	Limitation of glenohumeral and scapulothoracic motion	Roentgenograms of shoulder
12	37-64, average 50.33	M, 9 F, 3	12	Normal in 6; slight degeneration in 6

TABLE 8. DATA ON PATIENTS WITH CONTUSIONS.

No. of patients	Age	Sex	Range of motion of shoulder	Roentgenograms of shoulder
42	20-68, average 41.3	M, 39 F, 3	Normal in 17; minimal or slight limitation in 18; moderate or severe limitation in 7	Slight degenerative changes in 5 of 34; others normal

TABLE 9. OBSERVATIONS IN 44 PATIENTS WITH BICIPITAL SYNDROMES.

Condition	No. of patients	Age	Sex	Local tenderness over tendon or Yergason's sign[14]	Range of movement	Roentgenograms of shoulder
Tendinitis/tenosynovitis	39	20-64	M, 36 F, 3	37	Slight limitation in all patients in all directions, but adduction and extension rotation most affected	Minor degenerative changes in 4 of 32; others normal
Rupture (partial or complete)	5	34-61, average 46.4	M, 5 F, 0	5	Minimal limitation	Normal in 4 patients

TABLE 10. OBSERVATIONS ON PATIENTS WHO HAD SUFFERED DISLOCATION.

No. of patients	Age	Sex	Range of shoulder movement	Roentgenograms of shoulder
14	22-58	M, 14 F, 0	Some limitation in all	Normal in 5 of 12; some indentation or irregularity in 7

TABLE 11. DATA ON PATIENTS WITH FRACTURE DISLOCATION.

No. of patients	Age	Sex	Range of shoulder movement	Roentgenograms of shoulder
7	29-62	M, 7 F, 0	Limited in all	Anteroinferior dislocation with fracture of greater tuberosity in 2 patients; anteroinferior dislocation with fracture of surgical neck in 1 patient; anteroinferior dislocation with fracture of head of humerus in 1 patient; anteroinferior dislocation with fracture of glenoid in 2 patients

TABLE 12. DATA ON PATIENTS WITH PAIN FOLLOWING FRACTURE.

No. of patients	Age	Sex	Range of shoulder motion
16	25-76, average 29.3	M, 16 F, 0	Diminished in all patients, probably from disuse

"tendinitis" (average age, 44.9) or complete cuff rupture (average age, 56.6). Patients in this group complained of pain in the shoulder but because there was generally no localizing tenderness in the shoulder, no significant limitation of shoulder range, and no significant radiologic change in the shoulder, the diagnosis could not be specific, and the term "sprain" was used.

Tender motor points were found in 6 of 65 patients (9.2 percent). These also had some tenderness or limitation of movements of the cervical spine. Roentgenograms of the cervical spine of 5 of these showed evidence of spondylotic changes at levels corresponding to the myotomes within which the tender motor points were elicited.

In 25 patients the acromioclavicular joint (Table 14) was the source of pain, due to minor sprain, traumatic arthritis (with or without degeneration), subluxation, or dislocation. Localized tenderness was nearly always present, and pain was accentuated by adduction of the arm across the chest or circumduction. In the early stages of this condition there may be some limitation of active movements above the horizontal plane, but a full range of passive motion is usually present, with pain at the extremes of the range.

Tender motor points were elicited in only 1 patient, who also had slight limitation of movements of the cervical spine. Roentgenograms of the cervical spine showed narrowing between the fifth and sixth cervical vertebrae.

There were 11 patients with pain due to localized conditions in the shoulder not in any of the foregoing categories (Table 15). No tender motor points were elicited in any of these.

Group B

Group B, patients with "radiculitis" and referred pain from the neck, numbered 26 of the 407 patients (6.4 percent) (Table 16). In these the shoulder pain was recognized as referred from the neck because of accompanying pain and paresthesia or a "tingling" sensation radiating down the arm into the hand and fingers. Late neurologic signs generally were absent, and reflexes were normal. Tender motor points were found in all 26 in myotomes corresponding to the levels in which cervical and radiologic changes of spondylosis were seen. In these, cervical signs such as tenderness and loss of motion were present, and cervical roentgenograms of 22 patients showed radiologic evidence of spondylosis in 19 (to be discussed). These were at cervical levels corresponding to the myotomes where tender motor points were found in both rami.

One patient with symptoms and signs at one level (between C5 and C6) was shown subsequently to have spondylosis secondary to disk protrusion. The myelogram was positive and an anterior interbody fusion was performed with good results.

Group C

Group C, patients with no obvious signs, the prospective study group, made up the remaining 50 patients (12.3 percent) (Table 3). For these the diagnosis was not immediately apparent, since there were no localizing signs to implicate the shoulder joint. There was no significant restriction of motion of the shoulder joint, no painful arc, and no neurologic signs, and the roentgenograms of the shoulder were almost always normal. For these patients, the physical examination was essentially unrewarding except that they all had tenderness at motor points. From our previous experience[5,6] we have found that tenderness at motor points frequently is associated with neuropathy of the innervating nerve of the muscles involved, and, therefore, electromyography was performed on all 50 patients (Table 3).

Thirty-seven of the 50 patients were men and 13 were women. Their average age was 41.84 years, 10 being between 21 and 30, 14 from 31 to 40, 14 from 41 to 50, 8 from 51 to 60, and 4 being 61 or more.

Referring diagnoses as a rule were not concise but merely vague descriptions of the injuries. In 16 the

TABLE 13. DATA ON PATIENTS WITH PAIN DUE TO NONSPECIFIC "SPRAIN."

No. of patients	Age	Sex	Range of motion of shoulder	Roentgenograms of shoulder
65	18-60, average 35.3	M, 59 F, 6	Moderate limitation in capsular pattern, 3; slight limitation in extreme of range, 6; normal, 56	Normal in 40 of 43; slight degeneration in 3

TABLE 14. DATA ON PATIENTS WITH DISORDERS OF THE ACROMIOCLAVICULAR JOINT.

No. of patients	Age	Sex	Range of movement	Roentgenograms of shoulder
25	20-65, average 39.6	M, 24 F, 1	All normal except for slight limitation in 13 patients (52%)	Degenerative changes in 8 of 23; subluxation in 3; separation in 4; normal in 8

TABLE 15. DATA ON 11 PATIENTS WITH UNCLASSIFIED SHOULDER LESIONS.

No. of patients	Age	Sex	Diagnosis	Roentgenograms of shoulder
1	35	M	Injury to nerve of Bell and winging of scapula	Normal
1	28	F	Traction injury to shoulder	Normal
1	32	F	Malingering (so diagnosed by 4 examiners)	Normal
1	26	M	Avulsion of C5 and C6 nerve roots	Normal
1	25	M	Thoracic inlet syndrome	Normal
1	45	M	Fracture of scapular body (outside shoulder joint)	Normal
1	54	M	Soft tissue/severe crush injury	Normal
3	67	M	Traumatic aggravation of osteoarthritis	Degenerative osteo-arthritic changes
	59	M		
	64	M		
1	34	M	Hematoma (tear of biceps and triceps muscles)	Normal

TABLE 16. DATA ON PATIENTS WITH CERVICAL SPONDYLOTIC PAIN WITH RADICULITIS (WITHOUT SHOULDER LESION).

No. of patients	Age	Sex	Range of shoulder motion	Range of motion of cervical spine	Roentgenograms	
					Shoulder	Neck
26	20-64, average 45.3	M, 22 F, 4	Normal in 18; slight limitation in 8	Some limitation in lateral rotation or tilting in 25	Minor degenerative changes in 5	Radiologic evidence of spondylosis in 19 of 22

diagnosis was "contusion" from a fall or blow; 12, "shoulder strain"; 4, "traction-type injury"; and 5, merely "shoulder pain." Other diagnoses were "arthritis" in 1; "pericapsulitis" in 1; "hemarthrosis" in 1; "muscular ligamentous strains" in 2; and "rotator cuff tear" in 1. When tenderness of one particular motor point was most noticeable, it was mistaken for another condition with localized tenderness. In 5 a tender anterior deltoid motor point was classified as "bicipital tendinitis" (and surgery averted); in 1 a tender mid-deltoid motor point was diagnosed as "bursitis," and in 1 a tender motor point at the levator scapulae led to a diagnosis of "levator scapular syndrome." In only 1 patient was the cervical spine correctly implicated as the sole source of pain, but in 11 patients the neck was suggested as a secondary factor, although the referring physician was unable to demonstrate any relevant signs. In 1 patient, whose left pectoral motor points were tender and painful, myocardial pain was suspected, but the electrocardiogram and other laboratory tests gave normal results.

Roentgenograms of the shoulder joint were normal for 48 of the 50 patients. Two had some degenerative changes. Cervical roentgenograms were normal for 23 patients and showed minor degenerative changes for 10 and moderate to severe changes for 17 (to be discussed).

Electromyography showed some neuropathy in every patient, including slight denervation in 3. All had Grade 2 or 3 tender motor points, and the levels of cervical involvement and neuropathy corresponded with the myotomes where the tender motor points were observed. In general, the degree of tenderness at motor points and apophyseal joints paralleled the degree of neuropathy.

In contrast with our observations in our study of low-back pain,[5] in the present series signs of cervical neuropathy rarely were limited to one nerve root. Consequently, tenderness at motor points was elicited in almost all patients in more than one myotome, usually two (commonly C5 and C6). The patients therefore apparently had "primar, spondylosis," with widespread cervical changes not limited to one level. Only exceptionally were intervertebral disk protrusions involved. Trauma is seldom the initiating cause of primary spondylosis, although some incident, often minor, precipitated the symptoms in most cases. The distinction between diffuse primary spondylosis (degenerative) and secondary spondylosis (following trauma and usually limited to one level) has therapeutic implications. O'Connell[15] pointed out that treatment of primary spondylosis should be conservative, but when intervertebral disk protrusion causes severe neurologic disturbance it should be excised at the earliest opportunity (with benefit in a high proportion of cases). He stated also that when spondylosis is localized at one joint it should suggest the possibility of a disk protrusion at that level.

The results in the present series seemed to confirm O'Connell's opinion. All 50 patients responded to conservative treatment directed to the cervical spine.[16] Surgery rarely is indicated. In the entire series of 407 patients, only 1 patient (in Group B) required surgery (anterior interbody fusion). This patient had symptoms and signs limited to one level, and myelography confirmed the diagnosis of disk protrusion.

In all patients, when symptoms abated after treatment, whether conservative or surgical, tender motor points disappeared.

Although the average age of the 50 patients in Group C was 41.84 years, 10 patients (20 percent) were between 21 and 30, and 24 (48 percent) were less than 40. This suggests that primary spondylosis can occur in the young and is not always the result of degenerative changes. Other factors such as recurring minor trauma and structural or anatomic variations (to be discussed) are contributory causes.

Moreover, although it is obviously not possible to draw definite conclusions from a small series, women appear to be particularly susceptible to cervical spondylosis. Although women comprised only

TABLE 17. SUMMARY OF DATA.

Diagnosis	Table no.	No. of patients	No. of patients with tender motor points
Group A			
Rotator cuff injuries	5	90	10*
Bursitis	6	5	1*
Adhesive capsulitis	7	12	1*
Contusions	8	42	3*
Bicipital syndromes	9	44	0
Dislocations	10	14	0
Fracture dislocations	11	7	1*
Fractures	12	16	0
Nonspecific "sprains"	13	65	6*
Disorders of acromioclavicular joint	14	25	1*
Unclassified shoulder lesions	15	11	0
Group B			
Cervical spondylosis with radiculitis without intrinsic shoulder lesion	16	26	26
Group C			
Cervical spondylosis without intrinsic shoulder lesion and no obvious physical signs	3	50	50

*These patients were considered to have concurrent cervical spondylosis, evidenced by cervical signs (tenderness at apophyseal joints, limitation of motion), and cervical roentgenograms generally showed supportive evidence of degenerative changes at levels corresponding to myotomes where tender motor points were found.

26 per cent of Group C (13 of 50 patients), this was more than twice the usual proportion of women attending the clinic for all injuries (598 of 4,990 patients, or 12 percent, in 1974). A similar high proportion of women was observed in our series of patients with tennis elbow due to cervical causes.[6]

More than half the patients (52 percent) had a vague recollection of a precipitating incident, suggesting that the development of symptoms could have been insidious. Radiologic findings were normal for 16 of these 26 patients, mild for 3, and moderate or severe for 7.

Comment

A summary of data covering all three groups is presented in Table 17.

In cervical spondylosis there is progressive degeneration of the intervertebral disks leading to changes in the surrounding structures, especially the bones and meninges. In the past this condition has been called osteoarthritis, cervical spondylitis, herniated disk, and chondroma, but the term "spondylosis" is preferable, since the condition is degenerative, rather than inflammatory or neoplastic.[17] Spondylosis, per se, is part of the aging process, and produces no symptoms. By the eighth decade, said Irvine and associates,[18] it is almost universal. Symptoms occur only when the degenerative changes in the intervertebral disk or secondary changes in the adjacent vertebrae intrude on and affect pain-sensitive structures and one or more nerve roots or the cervical portion of the cord.

Pressure may occur at one or more levels, causing simultaneous damage to both nerve roots and cord, and paraplegia may occur.[19] Rheumatoid arthritis, ankylosing spondylitis, and Paget's disease are sometimes complicating factors.

In this paper, we have been concerned with the early manifestations of cervical spondylosis when nerve roots are impinged on to produce mild neuropathy or radiculopathy and referred pain to the shoulder. At this early stage, the condition is only a clinical entity (and easily missed), since there are no obvious physical signs in the shoulder or neck and the mild neuropathy may be recognized only by electromyographic examination. Roentgenograms of the cervical spine are equivocal and unreliable. Spondylotic pain can occur in the absence of radiologic changes, and radiologic evidence may indicate only the aging process and need not necessarily be accompanied by symptoms. Roentgenograms are therefore considered adjunctive to the clinical evaluation.

Spondylotic pain has no simple explanation and may originate from the synovial spinal joints, the intervertebral disks, or the bone of the vertebrae. Many possible mechanisms have been proposed,[17,20] among them compression by degenerative intervertebral disk material or extradural chondromas, interference with the blood supply, tethering by ligamenta denticulata, hypertrophy of the ligamenta flava, excessive movement between adjacent vertebrae, and constitutional stenosis of the spinal canal. Whatever the actual pathogenesis may be, however, an early result is pain, which either may be felt locally or may be transmitted via the spinal nerve to the corresponding myotome, dermatome, and sclerotome.[4] Since these areas of reference do not correspond with one another,[12] the resulting multiphasic clinical picture often causes confusion. Referred pain in the dermatome is felt as paresthesia; in the sclerotome as a nagging, deep pain; and in the myotome as muscle pain and tenderness. Muscle tenderness, when present, is maximal at the motor point over the neurovascular hilus where the nerve enters the muscle.

In spondylosis with radiculitis, referred signs are recognized easily, but when spondylosis is early or mild, referred signs of neuropathy are sparse and clinical detection difficult without electromyography. This is time consuming and not always available. At our clinic, we have found that tenderness of the muscular motor points generally occurs in association with electromyographic evidence of neuropathy. Our technique of examination may be learned quickly and incorporated easily into the routine examination of the shoulder. Elicitation of tenderness in the motor points may be used as an aid to recognition of the cervical level or levels of neuropathy when tenderness is found at motor points within the same myotomes (Table 4). Tenderness in muscles of both anterior and posterior rami of the segmental nerve isolates the lesion to a specific nerve root. (The rationale is comparable to that used in interpretive electromyographic observations.)

In this study, tender motor points always were found in patients with spondylosis and shoulder pain but not in patients with intrinsic causes of shoulder pain (unless there was accompanying spondylosis). Since electromyography was not performed on all the other 357 patients, it is possible (though it seems unlikely) that neck-derived shoulder pain may exist in the absence of tenderness at motor points. Nevertheless, the presence of tender motor points may be an important and useful diagnostic aid, leading the examiner to suspect the cervical spine as the source of pain.

With an awareness of the significance of tender motor points, the examiner is unlikely to mistake (and treat) motor point tenderness for such other conditions as bicipital tendinitis (a tender anterior deltoid motor point), shoulder bursitis (a tender mid-deltoid motor point), the levator scapular myofascial syndrome (a tender levator scapular motor point), supraspinatus tendinitis (a tender supraspinatus motor point), tennis elbow (tender motor points of the supinator and wrist extensors), or even cardiac pain when the pectoralis motor points are tender on the left side. Unnecessary or misdirected treatment may compound the problem. For example, injection of a steroid into the shoulder

joint is a common method of treatment, but the unnecessary needling of tender motor points mistaken for other entities may lead to iatrogenic avascular necrosis of the shoulder. Avascular necrosis of the humeral head has been reported[21] to occur in 20 percent of patients treated with steroids. In spondylosis, more than one motor point within the myotome will be tender, and, if necessary, the tender point could be established as a motor point by electrical stimulation. Other early signs such as slight muscle atrophy (best observed under an oblique light) and autonomic manifestations of pilomotor, sudomotor, and vasomotor effects have been, in general, insufficiently stressed.

Plain roentgenograms of the cervical spine or myelograms may be normal or show irrelevant degenerative changes. Positive-contrast diskography may yield false positive results roentgenographically, or nonspecific pain patterns may be observed clinically. Recently, cervical analgesic diskography was introduced,[22] and accurate results claimed.

Referred pain in the region of the shoulder may have its site of origin also in a viscus. Viscerosensory reflexes may arise from conditions of the diaphragm, gallbladder, heart (angina pectoris or myocardial infarction), pneumoperitoneum, and spleen. Recently, viral myocarditis appearing as myalgia has been reported.[23] Since the patients in the present study usually had suffered trauma and were drawn from candidates for workers' compensation, the other possible sites of intrasegmental pain were not investigated for possible tender motor points. We look forward to investigations by other workers in these fields, however, and the other possible sources of pain should provide their own relevant confirmatory signs.

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