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Tenderness at Motor Points

A DIAGNOSTIC AND PROGNOSTIC AID FOR LOW-BACK INJURY

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ABSTRACT: **In patients with low-back injury the motor points of some muscles may be tender. Of fifty patients with low-back "strain", twenty-six had tender motor points and twenty-four did not, while forty-nine of fifty patients with radicular signs and symptoms suggesting disc involvement had tender motor points, and the one without such tender points had a hamstring contusion which limited straight leg raising. Of fifty controls with no back disability, only seven had mild tender points after strenuous activity, while forty-six of another fifty controls with occasional back discomfort had mild motor-point tenderness. In all instances the tender motor points were located in the myotomes corresponding to the probable segmental levels of spinal injury and of root involvement, when present.**

Patients with low-back strain and no tender motor points were disabled for an average of 6.9 weeks, while those with the same diagnosis but tender motor points were disabled for an average of 19.7 weeks, or almost as long as the patients with signs of radicular involvement, who were disabled for an average of 25.7 weeks. Tender motor points may therefore be of diagnostic and prognostic value, serving as sensitive localizers of radicular involvement and differentiating a simple mechanical low-back strain from one with neural involvement.

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It is often difficult, if not impossible, to establish the cause of disability and to assess its degree in patients with low-back pain. While in some patients the diagnosis can

be made with no difficulty on the basis of the clinical history and physical examination, in others additional diagnostic tests including myelography and electromyography may be required. As a general rule, however, such tests are reserved for patients whose diagnosis is not clinically apparent or who are expected to require surgery. There remain, therefore, many patients with no localizing physical findings for whom ancillary tests are not considered necessary. The injuries in these patients are conveniently labeled "low-back sprain".

The physician, unable to make a firm diagnosis, may rightly or wrongly relate the pain to socioeconomic and psychophysiological factors, or may even suspect malingering. Therefore, many patients with genuine discomfort may not be treated appropriately simply because there are no significant physical findings.

The Workers' Compensation Board of British Columbia operates an Outpatient Rehabilitation Clinic to provide treatment after industrial injuries. So-called low-back sprain, a vague term encompassing a multitude of disorders, is one of the most common disabilities seen at the Clinic. In 1974, the total number of admissions for all types of injuries was almost 5,000, and 1,630 (33 per cent) of these were for injuries to the lumbar spine. Of these lumbar-spine injuries, 1,401 (86 per cent) were given a working diagnosis of low-back sprain. The remainder were fractures and postoperative conditions after laminectomies and spine fusions [8].

While performing electromyographic examinations in this Clinic over a period of four years, one of us (C. C. G.) discovered that some patients had tenderness at the motor points of some muscles. Initially, these tender areas were confirmed as being located at the motor points by showing that they were at sites where the minimum electrical stimulus evoked muscle twitches using a standard calibration-stable stimulator* with variable control of output [5]. These studies established that the motor points of certain muscles are frequently tender in patients with low-back pain. Furthermore, since the motor points are fixed anatomical sites and vary only slightly from person to person, a stimulator was not necessary to locate these points [2]. Electromyography also showed evidence of neuropathy in the nerves supplying these tender muscles, including increased insertion activity, more polyphasic action potentials, and prolongation of the mean duration of the motor-unit action potentials, their mean amplitude remaining normal or decreasing and a partial interference pattern being obtained even during maximum voluntary effort [6,7]. Whenever there is denervation or axonal degeneration, abnormal spontaneous activity of fibrillations and positive sharp waves appear. In mild neuropathy, electromyographic abnormalities are not obvious but are present as subtle differences from the normal state [5].

During the early part of this study, we also found that the degree of tenderness tended to parallel the severity of the symptoms and varied from week to week and even from day to day. Localized tenderness over specific motor points was not found in patients diagnosed as having hysteria or malingering. Because of these findings, we had to revise many previous diagnoses. For example, a dull ache or pain localized to a small tender area in the upper lateral quadrant of the buttock, which previously had been attributed to gluteal bursitis, was found to be the tender motor point of the gluteus medius. Similarly, tenderness at the motor point of the gluteus maximus (which is focal) had been mistaken for sciatic-nerve tenderness (which is linear). Tenderness described as trochanteric bursitis was found to be located at the tensor fasciae latae motor point, while tenderness thought to be caused by "adductor strain" and "rider's sprain" was found to be located at the motor points of the pectineus and adductor longus [3]. Tenderness was rarely limited to one motor point and a search for other points in muscles of the same myotome usually revealed their presence. If necessary, a tender point could be established as a motor point by electrical stimulation.

Methods and Material

Examination for Tender Motor Points

The procedure described here was gradually evolved during the past two years and is now in regular use at this Clinic. In accordance with established electromyographic principles [5], representative muscles of the second through the fifth lumbar and the first two sacral myotomes are examined, selecting muscles with accessible motor points (Table I). Trauma to a nerve root causes irritation or degeneration of nerve fibers, or both. These lesions may be detected during electromyography as increased insertional activity, polyphasic action potentials, fasciculation potentials, fibrillations, and positive sharp waves, or in the procedure described here as tender motor points in muscles of the affected myotome even though their segmental innervation comes through different peripheral nerves. Thus, the fourth lumbar myotome includes the following muscles: the anterior tibial, innervated by the fourth and fifth lumbar roots coming through the deep peroneal nerve; the tensor fasciae latae, innervated by the fourth and fifth lumbar roots coming through the superior gluteal nerve; and the quadriceps femoris, innervated by the second, third, and fourth lumbar roots coming through the femoral nerve. Abnormal findings in several muscles of one myotome differentiate the lesion from a peripheral neuropathy involving one nerve. However, since the number of nerve fibers from a given spinal segment supplying each muscle varies, it follows that electromyographic abnormalities and muscle tenderness will not be equally intense in all the muscles of the same myotome. Therefore, several muscles of the myotome under investigation are examined, with emphasis on those with the major segmental contribution (Table I). Examination of the paraspinal muscles which are innervated by the posterior primary rami is also necessary to confirm that the pathological process involves the segmental nerve at the

* TECA Model CH-3 Variable Pulse Generator and Chronaxie Meter.

root level, in which case muscles innervated by both anterior and posterior rami are involved.

The search for tender motor points may be easily incorporated into the regular examination of the low back, but a knowledge of the locations of the motor points [1] is essential (Figs. 1 and 2). With the patient prone and relaxed, motor points on the back and posterior aspect of the lower limb are examined. Pressure is applied with the thumb or one finger sufficiently firmly to compress the neurovascular hilus and motor end-plate zone (where the nerve enters the muscle) against the underlying bone. More pressure may be required in obese patients, especially for the motor points of the gluteus maximus and medius. The motor points of the paravertebral muscles (situated approximately 2.5 centimeters from the midline at segmental levels), and of the gluteus medius, gluteus maximus (occasionally two are present), biceps femoris

TABLE I

SEGMENTAL INNERVATION OF THE MUSCLES OF THE LOWER LIMB TESTED FOR TENDER MOTOR POINTS*

Predominant Cord Segment	Muscle (Segmental Innervation)	Peripheral Nerve
L2	Sartorius (L2, L3)	Femoral
	Pectineus (L2, L3)	Obturator
	Adductor longus (L2, L3)	Obturator
L3	Quadriceps femoris (L2-L4)	Femoral
L4	Quadriceps femoris (L2-L4)	Femoral
	Tensor fasciae latae (L4, L5)	Superior gluteal
	Tibialis anterior (L4, L5)	Peroneal
L5	Gluteus medius (L4-S1)	Superior gluteal
	Semimembranosus (L4-S1)	Sciatic
	Semitendinosus (L4-S1)	Sciatic
	Extensor hallucis longus (L4-S1)	Deep peroneal
S1	Gluteus maximus (L4-S2)	Inferior gluteal
	Biceps femoris, short head (L5-S2)	Sciatic
	Semitendinosus (L4-S1)	Sciatic
	Medial gastrocnemius (S1, S2)	Tibial
	Soleus (S1, S2)	Tibial
S2	Biceps femoris, long head (S1, S2)	Sciatic
	Lateral gastrocnemius (S1, S2)	Tibial
	Soleus (S1, S2)	Tibial

* Most muscles receive their innervation from more than one segment of the spinal cord, as indicated in this table in parentheses. The segments listed on the left are those generally accepted as the predominant source 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 are distributed to the corresponding levels of the erector spinae muscles, but there is extensive overlapping of the posterior rami.

(long and short heads), semitendinosus, and semimembranosus (Fig. 1) are systematically tested.

The patient is then examined in the supine position and the motor points on the front of the limb are similarly tested, including those of the pectineus, sartorius, tensor fasciae latae, adductor longus, rectus femoris, vastus medialis and lateralis, and tibialis anterior (Fig. 2). With the hips and knees flexed to about 60 degrees the motor points of the calf muscles may be reached from the front, with the fingers encircling the leg and applying pressure against the posterior aspect of the tibia over the motor

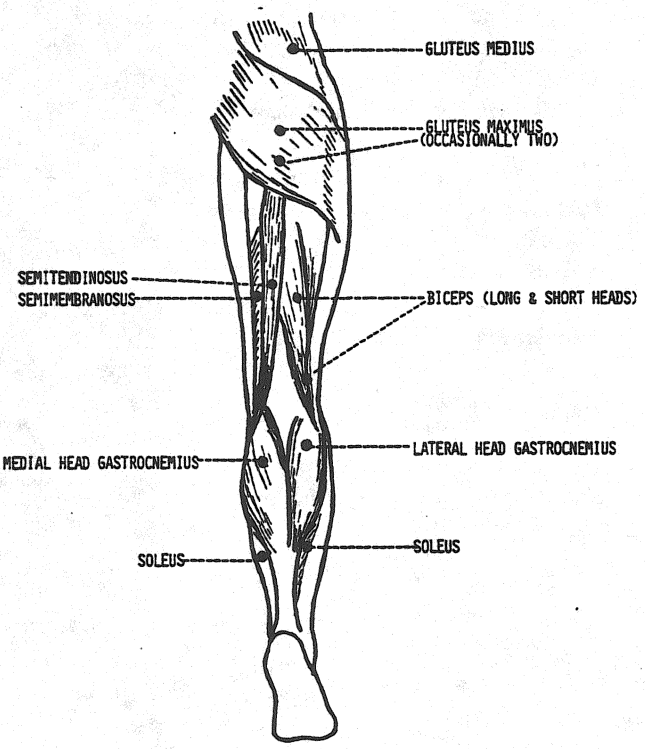

FIG. 1

Some motor points on the posterior aspect of the lower extremity.

points of both heads of the gastrocnemius and of the soleus.

With a little practice, any tenderness at these motor points may be quickly elicited, although some points are

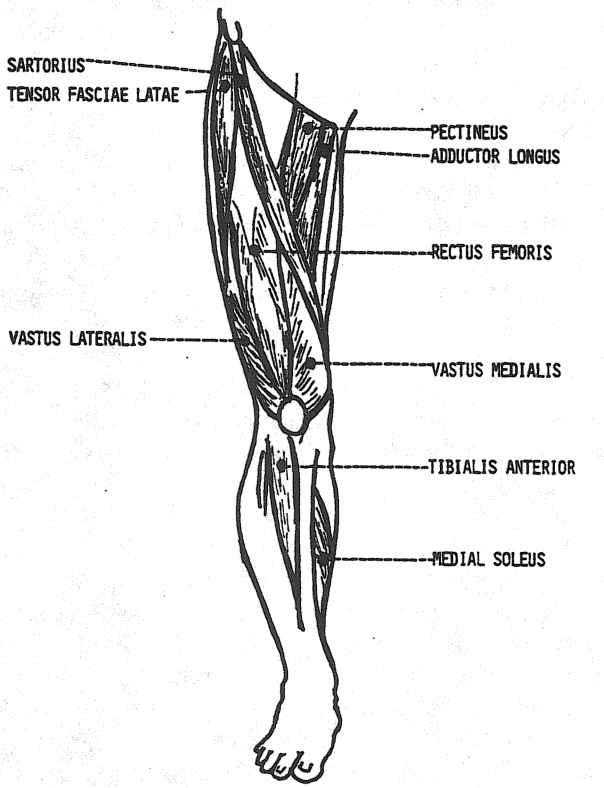

FIG. 2

Some motor points on the anterior aspect of the lower extremity.

more easily found than others. The tenderness is well localized to the approximate area covered by one palpating finger tip. Occasionally, the discoidal expansion of the neurovascular hilus may be palpable. The medial motor point of the soleus on the medial aspect of the lower part of the leg is especially easy to locate.

For the purposes of this study, the tenderness of the motor points was graded as follows:

Grade 0: No tenderness whatsoever is elicited by firm digital pressure.

Grade 1: Patient is aware of some tenderness as pressure is applied but it is not unpleasant.

Grade 2: Tenderness is moderate and unpleasant.

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

In this prospective study, 100 patients and 100 control subjects were examined and followed. They were divided into four groups:

Group A: Fifty consecutive patients with low-back sprain.

Group B: Fifty consecutive patients with disc involvement.

Group C: Fifty normal individuals with no history of back ache.

Group D: Fifty normal individuals with no previous medical treatment for back pain, but with occasional back ache after unusual stress or activities.

Patients with Low-Back Pain (Groups A and B)

The 100 patients with low-back symptoms (low-back sprain or disc involvement) were selected from the 147 consecutive patients seen between September 8 and December 21, 1974. The forty-seven patients who were excluded were seven with lumbar vertebral-compression fractures, twenty-two with roentgenographic findings of advanced degenerative osteoarthritic changes, and eighteen who had had laminectomy or spine fusion. The patients who were included were followed until they returned to work in order to obtain data on the duration of their disability.

All patients were given a complete physical examination with emphasis on the low back. Apart from their back pain, they were in good health. Roentgenograms of the lumbosacral spine, including oblique views, were obtained. Ten Group-B patients had myelograms and six of these showed some indentation of the column of contrast medium.

A detailed history was taken to determine if there was a relationship between the nature of the injury, the duration of disability, and the presence of tender motor points. The duration of disability was taken to be the time between injury and return to employment. As is well known, patients receiving compensation are reluctant to return to work unless entirely satisfied; thus, the periods of disability found in this study should be considered in that light. All patients were managed conservatively with the standard Clinic regimen [8]. After injury, those in acute discomfort were managed at home or in a hospital following a regimen of strict bed rest, local heat, and analgesic medication with or without muscle relaxants until they were sufficiently improved to attend the Clinic as out-patients. The Clinic regimen included physiotherapy (to alleviate pain and muscle spasm) followed by graduated remedial exercises (to improve posture and muscle tone) as well as occupational therapy or industrial activities as tolerance improved. Patients also received instruction in the care of the back and in proper bending and lifting techniques.

TABLE II

AGE DISTRIBUTION OF PATIENTS IN GROUPS A AND B

Age	Group A	Group B
20 years and less	2 (4%)	4 (8%)
21 to 30 years	16 (32%)	6 (12%)
31 to 40 years	11 (22%)	14 (28%)
41 to 50 years	14 (28%)	16 (32%)*
51 to 60 years	6 (12%)	8 (16%)
Over 60 years	1 (2%)	2 (4%)

* During the period when the data were collected, eighteen postoperative patients (laminectomies and spine fusions) were also admitted but they were not included in the study. Their average age was forty-six years. If they are considered as having "disc involvement", then the age group between forty-one and fifty years old was the most vulnerable.

The patients in Groups A and B included eighty-nine men and eleven women. Their age distribution is detailed in Table II.

Control Subjects (Groups C and D)

Our original plan was to have a control group of 100 patients who had been admitted to the Clinic for unrelated complaints. However, to accumulate only fifty patients without a past history of low-back disability, we had to screen and examine 328 individuals. Therefore, it seemed likely that these fifty patients were not representative of a normal cross section of the population, and we decided to use 100 members of the lay staff of the Workers' Compensation Board as controls. They were collected from the 141 employees who were screened and included eighty-six men and fourteen women, all in good health. Their combined age and sex distributions were comparable to those of the patients in Groups A and B, as shown in Table III.

All of the subjects who were to be used as controls

TABLE III

	Groups C and D (Control)	Groups A and B (Study)
Males	86	89
Females	14	11
Age group		
20 years and less	3	6
21 to 30 years	24	22
31 to 40 years	23	25
41 to 50 years	29	30
51 to 60 years	16	14
Over 60 years	5	3

TABLE IV

GROUP A — "LOW-BACK SPRAIN" WITH TENDER MOTOR POINTS AND NO RADICULAR SIGNS (TWENTY-SIX PATIENTS)

Case	Age, Sex (*Yrs.*)	Disability Period (*Wks.*)	Side	Tender Motor Points (Grades 1 to 3): Erector Spinae L2	Erector Spinae L3	Erector Spinae L4	Erector Spinae L5	Pectineus	Add. Long.	Sartorius	Rect. Fem.	Vast. Med.	Vast. Lat.	Semi-M/T	Biceps Fem.	Tib. Ant.	Lat. Gastroc.	Med. Gastroc.	Soleus	Glut. Med.	Glut. Max.	Roentgenogram
1	45,F	28	L			2	2								3			3	3	3	2	Degen. changes L5-S1
			R			2	2											2		3	2	
2	50,M	18	L			2	2					1						2	2	2		Degen. changes L4-S1
			R			2	2					1						2	2	2		
3	27,M	17	L				2													2	2	Normal
			R				2													2		
4	60,M	26	L			2	2											2	3	2		Degen. changes L4-S1
			R			2	2											1	2			
5	40,M	19	L				1											2	2			Slight degen. changes L5-S1
			R				1															
6	50,M	24	L				2							2				2	3	2	2	Degen. changes L5-S1
			R				2															
7*	39,M	88	L			2	3												2	2		Degen. changes L5-S1
			R			2	3												3	3		
8	44,F	34	L			2	2								2			3	3	2	2	Degen. changes L5-S1
			R				1															
9	59,M	28	L				2											2	3	3	1	Degen. changes L4-S1
			R				2												1			
10	30,M	14	L			2	2				1	1	1					1	2	1	1	Normal
			R				2												1			
11	37,M	21	L				2											2	3	2		Degen. changes L4-S1
			R				2											2	2	2		
12	50,M	29	L		2	2	1				1	2	1		2			2	3	2	2	Degen. changes L3-L4
			R				1															
13	49,M	18	L			1	1											1	2	2	1	Degen. changes L4-L5
			R			1	1												1			
14	46,F	12	L				1											1	2	1	1	Normal
			R				1											1	2	1	1	
15	21,M	14	L				1															Normal
			R				2										1	2	2	2	2	
16	47,M	15	L																			Degen. changes L4-L5
			R			2	1								2		2			2	2	
17	24,M	18	L				1							1	1			1	2	2	1	Normal
			R				1												2			
18	29,M	19	L				2												1			Normal
			R				3											2	2	2	2	
19	45,M	18	L				2											2	2	2	2	Normal
			R				2												1	1		
20	40,M	15	L				2										2	2	2	1	1	Normal
			R				2											1	2			
21	53,F	18	L																			Slight degen. changes L4-S1
			R				2										2	2	2	2	2	
22	43,M	16	L															2	2	2	2	Degen. changes L5
			R											2				2	2	2		
23	24,M	26	L				2											2	3	3	2	Normal
			R				1													2		
24	58,M	22	L	2	2	2		2	2	1	1	1						2	2	2		Degen. changes L2-L4
			R	2	2	2		2	2	1	1	1						2	2	2		
25	50,M	12	L				2											2	2	1		Normal
			R				2											2	2	1		
26	40,M	13	L			2	2											1	1			Normal
			R			2	2											2	2			

* This patient was eventually operated on and a central lumbosacral disc was found. The disability period was further extended to 102 weeks.

TABLE

GROUP B — "DISC INVOLVEMENT" WITH PROBABLE PREDOMINANT INVOLVEMENT OF THE THIRD LUMBAR-

Case	Age, Sex (*Yrs.*)	Disability Period (*Wks.*)	Side	Physical Signs: Fem. Stretch Test	Knee Jerk↓	Loss of Sensation	Quad. Weakness or Atrophy	Erector Spinae L2	Erector Spinae L3	Erector Spinae L4	Pectineus	Add. Long.
1*	61,M	32	L	+	+		+	2	2		3	3
			R					2	2		2	2
2	38,M	17	L									
			R	+	+				2	2		
3	52,M	21	L	+					2	2		
			R	+	+	+	+	2	2	2		
4	37,M	21	L						2	2		
			R									
5	35,M	26	L	+			+		2	2		
			R						2	2		
6	20,M	22	L	+					2	2		
			R						2			

* Case 1 appeared to have disc involvement at the interspace of the second and third lumbar vertebrae with involvement of the root at the third lumbar level, while the other patients appeared to have disc involvement at the interspace of the third and fourth lumbar vertebrae with irritation of the root at the fourth lumbar level.

were interviewed and examined. Anyone who had a history of low-back disability (time loss from work) or of medical or chiropractic treatment for low-back ache was excluded. The controls used had the routine back examination given to patients on admission to the Clinic and were also examined for tender motor points. Standard roentgenograms of the low back were obtained, including oblique views if the radiologist considered them necessary.

The control subjects were divided into two groups: Group C, fifty men and women who had no back disability; and Group D, fifty men and women who considered themselves normal, without back discomfort at the time although they had had occasional low-back discomfort after unusual activity.

Results

Group A – Low-Back Sprain

The Group-A patients with low-back sprain had had an acute ligament or muscle injury. They had no history of previous back surgery, no radicular symptoms such as pain radiating into the groin, buttock, or lower limb, and no feeling of weakness, numbness, or paresthesia. They also had no radicular signs such as limitation of straight leg raising, a positive Lasègue or Ely sign, reflex changes, sensory changes, motor weakness, or muscle atrophy. In addition, their roentgenograms were within normal limits or showed no more than minimum degenerative changes consistent with age or minor congenital abnormalities. None showed spondylolysis or spondylolisthesis. Of these fifty patients, there were twenty-six (52 per cent) who had tender motor points and twenty-four (48 per cent) who did not. These two subgroups were compared with respect to roentgenographic changes, mechanism of injury, and duration of disability. Fifteen of the twenty-six patients with tender motor points had roentgenographic abnormalities (Table IV), while only two of the twenty-four without tender points had such findings.

The history of the mechanism of injury revealed that injuries involving trunk rotation or a "twist" combined with lifting, falling, pushing, or pulling had occurred in eighteen of the twenty-six patients with tender motor points and in only three of the twenty-four with no tender points. In the other twenty-nine patients the injuries did not involve trunk rotation.

The duration of disability (to the nearest week) ranged from twelve to thirty-four weeks (average, 19.7 weeks) in twenty-five of the twenty-six patients with tender motor points; in one (Case 7, Table IV) a central disc protrusion was eventually found at operation. In the twenty-four patients with no tender motor points, on the other hand, the disability period ranged from three to thirteen weeks (average, 6.9 weeks).

Group B – Disc Involvement

The Group-B patients had symptoms and signs of radicular involvement and all but one of them had tender motor points (Tables V-A and V-B). The one exception was a man (Case 50, Table V-B) who was injured in a fall and had limited straight leg raising. The history suggested that he had sustained a contusion of the hamstring muscles and that this, rather than radicular involvement, was responsible for the limited straight leg raising. Although many of the patients with tender motor points had unilateral symptoms, as often as not their tender motor points were bilateral.

Correlation of the tender motor points and signs of radicular involvement suggested that the distribution of the motor points could be of some localizing value. Thus, in Case 1 in Table V-A, the patient had a depressed knee jerk, quadriceps atrophy, and a positive femoral stretch

V-A

NERVE ROOT (AT L2-L3 INTERSPACE) AND OF THE FOURTH LUMBAR-NERVE ROOT (AT L3-L4 INTERSPACE)

Tender Motor Points (Grades 1 to 3)									
Rect. Fem.	Vast. Med.	Vast. Lat.	Tib. Ant.	Lat. Gas-troc.	Med. Gas-troc.	Soleus	Glut. Med.	Glut. Max.	Roentgenogram
1	2	1							Degen. changes L1-L3
1									
2	3	2							Disc-space narrowing and degen. changes L2-L4
			1	1	1	2	1		Degen. changes L3-L4
2	3	2	1	1	1	2	2		
2	2		2		1	2			Degen. changes L4-S1
3	3	2							Normal
2	2	2							Normal

test — findings indicative of involvement of the second and third lumbar-nerve roots. His roentgenograms also showed degenerative changes involving the first, second, and third lumbar vertebrae. Examination for tender motor points in this patient revealed acutely tender points in the muscles of the second and third lumbar myotomes. Similarly, in Cases 2 through 6 in Table V-A, the patients, with one exception, showed clinical evidence of involvement of the third and fourth lumbar-nerve roots and all had tender motor points in the quadriceps, while three also had similar points in other muscles in the third and fourth lumbar myotomes. Finally, in Cases 7 through 50 in Table V-B, the patients showed some evidence of involvement of the fifth lumbar or first sacral-nerve root and all had tender points in muscles supplied by these roots.

Of the fifty Group-B patients, thirty-nine, including the one with a probable contusion of the hamstrings (Case 50, Table V-B) had roentgenographic changes which included disc-space narrowing with or without associated degenerative changes.

Thirty-one of the Group-B patients had sustained injuries which involved rotation or a twist of the trunk combined with lifting, pushing, pulling, or falling, and thirty of these thirty-one patients had tender motor points.

The duration of disability of the forty-nine patients in Group B with tender motor points ranged from fourteen to seventy-two weeks (average, 25.7 weeks), while the one patient with no tender motor points was disabled for only eight weeks.

Group C – No Back Disability

The Group-C subjects with no back disability showed no positive findings on physical examination except that seven of them (14 per cent) had Grade-1 tender motor points in either the soleus or the medial head of the gastrocnemius. These seven individuals had recently engaged in unusual activity, such as jogging, shoveling snow, or strenuous calisthenics; their tenderness disappeared a few days later, only to recur whenever they increased their activities.

The roentgenograms of thirty-one of the Group-C subjects were normal, while those of the other nineteen showed minor degenerative changes consistent with their age (average age, forty-seven years; range, thirty to sixty-four). These degenerative changes were located between the fourth lumbar and first sacral vertebrae in eleven and between the third and fourth lumbar vertebrae in one. In six others the changes were generalized, while the remaining patient had a Grade-I spondylolisthesis. The roentgenograms of the seven patients with Grade-1 tender motor points after unusual activities did not differ appreciably from those of the group as a whole. Of these seven roentgenograms, two were normal, one showed that the fifth lumbar vertebra was partially sacralized but was otherwise normal, and the other four showed slight degenerative changes between the third and fourth lumbar vertebrae in one and below the fourth lumbar vertebra in the other three, including one with slight narrowing of the lumbosacral disc space.

Group D – Occasional Back Discomfort

The Group-D subjects who had had occasional back pain tended to avoid excess stress on the back because of the discomfort, but all were in good health and at the time of examination had no back pain. Their physical examinations were negative except that forty-six (92 per cent) had Grade-1 or Grade-2 tender motor points. Of these fifty controls, twenty-two had normal roentgenograms, eighteen had minor degenerative changes or anomalies and no narrowing of the disc spaces, and ten had definite degenerative changes, usually combined with disc-space narrowing.

Of the twenty-two with normal roentgenograms, one had no tender motor points and twenty-one had from one to five tender points, giving an average number of 2.2. Four of these individuals had tender points in muscles, of

TABLE V-B

GROUP B — "DISC INVOLVEMENT" WITH PROBABLE PREDOMINANT INVOLVEMENT OF THE LUMBOSACRAL OR FIRST SACRAL-NERVE ROOTS (AT THE INTERSPACE OF THE FOURTH AND FIFTH LUMBAR OR THE FIFTH LUMBAR AND FIRST SACRAL VERTEBRAE)

Case	Age, Sex (*Yrs.*)	Disability Period (*Wks.*)	Side	Radicular Signs: Limitation Straight Leg Raising	Radicular Signs: Ankle Jerk↓	Radicular Signs: Loss of Sensation	Radicular Signs: Muscle Weakness or Atrophy*	Tender Motor Points (Grades 1 to 3): Erector Spinae L4	Erector Spinae L5	Semi-memb.	Semi-tend.	Biceps Fem.	Tib. Ant.	Lat. Gastroc.	Med. Gastroc.	Soleus	Glut. Med.	Glut. Max.	Roentgenogram
7	34,M	70	L	+					2						2	2	2		Myelogram indentations L4-S1
			R	+		+	CT		2						3	3	3		
8	25,M	20	L																Disc-space narrowing L5-S1
			R	+					2			2				2	3	2	
9	35,M	21	L	+				2	2				2				2	2	Slight disc-space narrowing L4-S1
			R	+				2	2				2				2	2	
10	45,M	18	L	+					3			2			2	3	3	2	Degen. changes L4-S1
			R						2										
11	52,M	28	L						2								2		Slight disc-space narrowing L4-S1
			R	+					3			2			2	3	2	2	
12	44,M	22	L				CT		2							2	3		Disc-space narrowing L5-S1
			R						2					2	2	3	2		
13	41,M	20	L	+					3								3	2	Normal
			R																
14	54,M	72	L	+					2							2			Disc-space narrowing L5-S1
			R	+			C	2	3					2	2	3	3	2	
15	41,M	16	L	+					2					2	2	3	3	2	Disc-space narrowing L5-S1
			R																
16	44,M	28	L	+				2	3	2	2	2			2	3	3	2	Disc-space narrowing L5-S1
			R																
17	46,M	21	L						2										Slight degen. changes L4-S1
			R	+					2						2	3	2		
18	25,M	24	L	+	+				2					2	3	3	3	2	Disc-space narrowing L4-S1
			R																
19	41,M	32	L	+				1	2						2	3	3		Slight disc-space narrowing L4-L5
			R					1	2										
20	42,F	31	L						2										Myelogram indentation L5-S1
			R	+					2				2		3	3	3	2	
21	39,M	32	L	+	+				3						3		3	3	Myelogram indentation L4-L5
			R						2										
22	51,M	19	L						1										Normal
			R	+					2						2	2			
23	45,M	22	L	+				2	2						2	3	2	2	Degen. changes L4-L5
			R																
24	20,M	19	L	+					2							3			Normal
			R	+					2						2	3			
25	31,M	24	L	+		+	C		3						2	3	3		Myelogram indentation L5-S1
			R				C		2								2		

26	38,M	14	L							2								2			Degen. changes, disc-space
			R	+						2						2	3	3	2		narrowing L4-S1
27	18,M	18	L	+						2											Myelogram indentation L5-S1
			R	+						2								2	2		
28	27,M	22	L	+				C		3							2	3	2		Normal
			R							2											
29	39,M	24	L							2	2	2									Normal
			R	+		+				2						3		3	2		
30	31,M	31	L	+	+				2	3	2	2				3	3	3	2		Disc-space narrowing L4-S1
			R	+					2	3	2	2				2	2	2	2		
31	53,M	19	L	+				CT		2						2	2	2			Slight degen. changes L5-S1
			R																		
32	46,M	22	L	+						2						2	2				Myelogram indentation L5-S1
			R													2	2				
33	52,M	52	L							2							2				Slight disc-space narrowing L5-S1
			R	+	+			C	2	2	2	2				2	3	2	1		
34	35,M	22	L	+				T		3	2					2	3	2			Disc-space narrowing L5-S1
			R	+				T		3	2										
35	29,M	21	L					C		2	2					2	3	2	2		Slight degen. changes L5-S1
			R																		
36	46,F	18	L	+					2	2			2	2		2	3	3	2		Disc-space narrowing L4-L5
			R	+					2	2			2			2	2	2	2		
37	44,F	24	L	+	+				1	2					2	3	3				Disc-space narrowing L5-S1
			R						1	1							1				
38	52,M	18	L						1	2							1				Normal
			R	+						3			2		2	3	3				
39	29,M	20	L																		Slight degen. changes L4-S1
			R	+					1	2	2	1				2	1				
40	43,F	24	L						1												Disc-space narrowing L5-S1
			R			+			1	2		2					2	2			
41	36,M	54	L							2											Normal
			R		+				2	3						2	3	3			
42	26,M	22	L	+						2	2	2				3	3	3			Disc-space narrowing L5-S1
			R	+						2								2			
43	32,M	16	L	+				CT	1	2						2	2	2			Normal
			R																		
44	37,F	22	L	+						2	2	2				2	3	2	2		Slight degen. changes L5-S1
			R							1											
45	20,M	32	L	+						2						2	3	3			Degen. changes L5-S1
			R							2								2			
46	62,M	22	L	+						2			2		2			2	3		Degen. changes L4-L5
			R																		
47	51,M	32	L		+			CT	2	2			2			3	3	2			Disc-space narrowing L4-S1
			R						2	2						2	3	2			
48	41,F	21	L			+		T		3						3	3	3	1		Degen. changes L4-S1
			R							2								2			
49	45,M	14	L	+					2	2						3	3	3	2		Min. degen. changes L5-S1
			R							2						2		2			
50	44,M	8	L						No tender points; probable contusion to hamstrings												
			R	+																	

* C = calf muscles/plantar flexion of foot; T = dorsiflexion of great toe and foot.

which some were innervated by anterior and some by posterior rami, and eighteen had tender points only in muscles innervated by anterior rami.

Of the eighteen controls with minor degenerative changes but no disc-space narrowing, two had no tender points and sixteen had from two to six, giving an average of 2.8 tender motor points per person. Four had tender points in muscles, of which some were innervated by anterior and some by posterior rami, and thirteen had tender points only in muscles innervated by anterior rami.

Of the ten controls with degenerative changes and disc-space narrowing, one had no tender motor points and nine had from two to six, for an average of 2.5 tender points per person. Three had tender points in muscles, of which some were innervated by anterior and some by posterior rami, while the other six had tender points in muscles innervated by anterior rami alone.

No correlations were evident between the locations, numbers, and grades of the tender points and the location of the degenerative changes visible on the roentgenograms.

Since the subjects in Group D with degenerative changes were asymptomatic and the incidence of tender points was no higher in them than in the other members of Group D without degenerative changes, all fifty Group-D controls were included in the study despite the roentgenographic evidence of degenerative changes in some.

Discussion

It is generally agreed that virtually everyone eventually has some degenerative joint disease in the low back, but that as a rule problems arise only when the degeneration has reached a certain degree and some incident, which may be minor, precipitates symptoms.

In this study it was found that an injury involving flexion combined with rotation of the lumbar spine is most likely to cause prolonged disability and that tender motor points may be useful in assessing back problems, particularly when no positive physical signs are detectable.

Tender motor points of a mild and transient nature may occasionally be found in normal, asymptomatic individuals, especially after unusual activity. Mildly or moderately tender motor points are usually present in individuals who give a history of a so-called vulnerable back or who have had lesser degrees of trauma. Newman suggested that a vulnerable back and few symptoms and signs probably represent the first stage of lumbar weakness, a stage that is likely to progress to other syndromes of lumbar insufficiency [9]. These asymptomatic subjects may have minor degenerative changes visible on roentgenograms, which are generally dismissed by clinicians as incidental. However, in these people disability after back injury tends to be prolonged and tender motor points are more commonly found. Thus, fifteen of the twenty-six patients with low-back strain and tender motor points (Table IV) and thirty-seven of the fifty with evidence of root involvement and tender motor points (Tables V-A and V-B) had roentgenographic changes, while only two of the twenty-four patients with low-back strain and no tender motor points had such changes. These findings suggest that the presence or absence of tender motor points might be significant in pre-employment medical examinations.

Moderately to acutely tender motor points are almost constantly found in patients with disc degeneration. The degree of tenderness and the number of tender points tend to parallel the patient's condition and may serve as indicators of progress.

The probable segmental level of a lesion is suggested when there are tender motor points in muscles which are in the same myotome and receive their innervation through different peripheral nerves. The presence of tender motor points in muscles innervated by the upper lumbar-nerve roots may be reason to suspect lesions at high lumbar levels for which the straight-leg-raising and femoral stretch tests are of no diagnostic or localizing value (Tables V-A and V-B). Possibly because they have a plurisegmental nerve supply, some muscles do not have tender motor points. Tenderness in muscles innervated by both the anterior and the posterior ramus of one root identifies the level of the lesion. In patients with unilateral symptoms, as often as not there are tender motor points on both sides, suggesting bilateral involvement.

An important finding in this study was that patients admitted to the Clinic with low-back sprain and no tender points were disabled for an average of 6.9 weeks, while those with low-back sprain and tender points were disabled for an average of 19.7 weeks, almost as long as patients with radicular signs, who were disabled for an average of 25.7 weeks. Tender motor points, may, therefore, be a sensitive indicator of radicular involvement. Recovery time may be related to the degree of trauma sustained. Denny-Brown and Brenner showed that mild percussive trauma to a nerve leads to swelling and local edema together with dissolution of the myelin, and recovery takes at least four to five weeks, while after trauma sufficiently severe to lead to Wallerian degeneration recovery takes at least twelve weeks.

Patients seen for the first time who show no physical signs except tender motor points deserve attention and continued surveillance, while those without tender points should be carefully assessed and examined to rule out other causes of low-back pain or disability, such as retroperitoneal and abdominal lesions or psychosomatic problems.

Conclusions

Although disc herniation with classic signs is usually not a diagnostic problem, low-back pain without significant physical signs may present a diagnostic challenge. Tender motor points may be a clue under these circumstances.

This study suggests that muscle tenderness, maximum at motor points, can be elicited during the routine

examination of the back and be a useful diagnostic and prognostic sign in this enigmatic group of low-back sprains.

Patients diagnosed as having simple low-back sprain but demonstrating acutely tender motor points will have a period of disability approaching that of patients with radicular signs, while patients with no tender motor points can be expected to do well.

Absence of tender points in patients with severe complaints and equivocal physical findings should raise doubts as to the presence of any significant lesion in the lumbar spine.

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References

1. CHUSID, J. G.: Correlative Neuroanatomy and Functional Neurology. Ed. 15, pp. 236-237. Los Altos, California, Lange Medical Publications, 1973.
2. COERS, C.: Note sur une technique de prélèvement des biopsies neuro-musculaires. Acta Neurol. Psychiat. Belgica, 53: 759-765, 1953.
3. CYRIAX, J. H.: Textbook of Orthopaedic Medicine. Ed. 5, p. 646. London, Baillière, Tindall and Cassell, 1969.
4. DENNY-BROWN, D., and BRENNER, CHARLES: The Effect of Percussion of Nerve. J. Neurol., Neurosurg., and Psychiat., 7: 76-95, 1944.
5. GOODGOLD, JOSEPH, and EBERSTEIN, ARTHUR: Electrodiagnosis of Neuromuscular Diseases, pp. 3 and 164. Baltimore, Williams and Wilkins, 1972.
6. GUNN, C. C., and MILBRANDT, W. E.: Tennis Elbow and the Cervical Spine. Canadian Med. Assn. J., 114: 803-809, 1976.
7. GUNN, C. C., and MILBRANDT, W. E.: Unpublished data.
8. MILBRANDT, W. E., and GUNN, C. C.: A Comprehensive and Progressive Rehabilitation Programme for Low Back Strain as Applied at the Workers' Compensation Board of British Columbia. *In* Proceedings, International Symposium on the Rehabilitation of the Industrially Injured. Vancouver, British Columbia, Canada, April 1973.
9. NASSIM, REGINALD, and BURROWS, H. J.: Modern Trends in Diseases of the Vertebral Column, p. 268. London, Butterworths, 1959.