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STUDIES ON MUSCULAR STRENGTH-MYOGRAM (MSMG)

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ABSTRACT

A new apparatus consisting of a strain gauge and carrier amplifier was devised by Konno for measuring back muscular and shoulder-arm strength. The apparatus was used for analysing myogenic disorders related to muscular fatigue or pain. Muscular strength with load and its myogram were recorded simultaneously, and their changes were analyzed. Muscular strength--myograms of the sternocleidomastoid, upper trapezius, deltoid, rhomboid and lumbodorsal muscles were recorded from the back muscular strength-myogram, and those of the teres minor and major pectoral muscles, from the shoulder-arm strength-myogram.

It was observed that despite the lowering of muscular strength through muscular fatigue and pain, the amplitude of the action myogram increases: the greater the lowering of muscular strength, the larger the amplitude.

The authors have devised a method of measurement by designating muscular strength as "X" and myogram amplitude as "Y". A device has been developed for recording the XY values simultaneously with measurement. In the case of the back muscle MSMG, the order of the proportion of Y to X values is: in both males and females upper trapezius portion, lower back portion, interscapular portion, and side of the neck portion. Methods for diagnosing the degree of abnormality in the muscular region will require further study.

Compared to the XY curve of a normal person, that of patients suffering from abnormalities such as muscular fatigue and pain appears as a much steeper curve inclined to the Y side. This makes it much easier to diagnose the severity of the patient's trouble.

The fact that amplitudes of the muscular strength-myogram increase as muscles become fatigued is already known. With the idea that pain resulting from fatigued muscles could also be measured, the authors developed a MSMG measuring method[1] using the back, shoulder-arm and gripping strength meters.

Additionally, in order to handle measurements obtained, a method of calculating the differences between the areas covered by myogram amplitude and by muscular strength curve, as well as an XY correlation method, were studied. In this report, the results of MSMG measurements of the neck, shoulder, back and waist portions are presented.

APPARATUS AND METHOD OF MEASUREMENT OF BACK MSMG

A polygraph was used in MSMG measurement. A carrier amplifier connected to a back muscular strength strain gauge was linked to the polygraph to measure back muscular strength. A block diagram of this apparatus is shown in Figure 1. The grip bar of the back muscular strength meter was adjusted to move through 60 degrees up and down as shown in Figure 2.

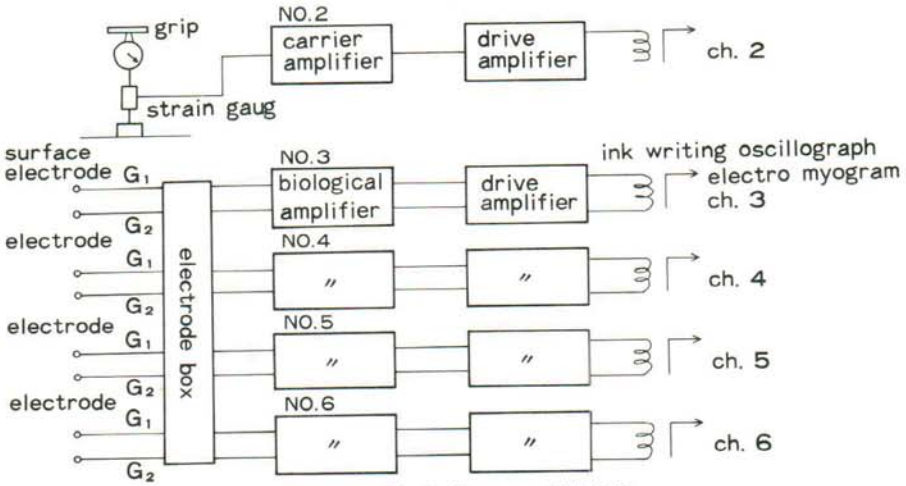

FIG. 1 – Block diagram of MSMG.

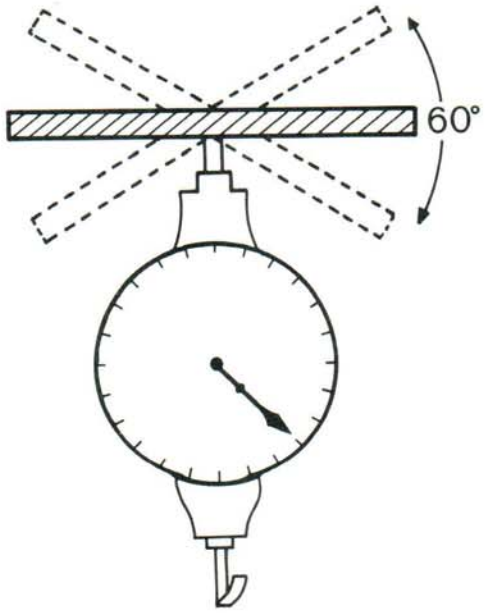

FIG. 2 – Back muscular strength meter. The grip pole is possible to move at an angle of 60 degrees of the back muscular strength meter.

Electrodes were flat metal discs 10 mm in diameter, placed 5 cm apart, with bi-polar lead. Voltage calibration was set at 200 kg-40 mm for back muscular strength, 1 mV – 10 mm for the myogram with a time constant of 0.01 second and paper speed at 2 cm/second and 5 cm/second.

The areas of measurement were back muscles, stiff and painful muscles, etc., with electrodes attached to the left and right sides (Figure 3). The positioning of the electrodes and portions of the measurement appear in the chart. The measuring method of the back muscular strength is the same as in the normal measuring method of back muscular strength (Figure 4).

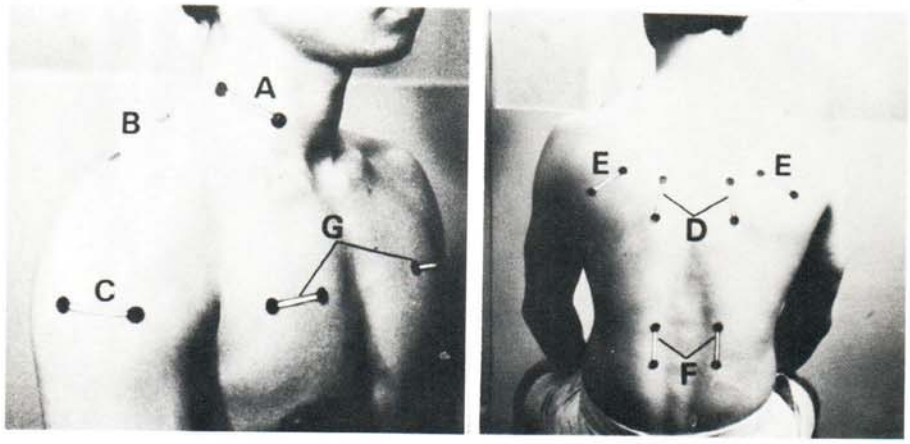

FIG. 3 – Sites of electrode application. A: neck-side portion (the sternocleidomastoid muscle); B: upper trapezius muscular portion; C: deltoid muscular portion; D: interscapular portion (the rhomboid muscle); E: scapular portion (the teres minor muscle); F: lower back muscular portion (the lumbodorsal fascia); G: upper chest portion (the major pectoral muscle).

CASES OF MEASUREMENT OF BACK MSMG

The muscles involved in the pulling action are: interscapular muscles, trapezius muscles and the neck-side muscles which raise the scapula, and the back muscles used to raise the upper torso. If there is pain in any of these, abnormal electric discharges can be expected to appear in the myogram. MSMG of the neck portion is shown in Figure 5.

The patient was 29 years old, male, complaining of neck pains, with the pain on the right side much greater than that on the left. As in Figure 5, the myogram amplitudes increased in parallel with muscular strength. The amplitude of the more painful right side (channel 4) was much greater than that of the left side (channel 3).

MSMG of trapezius and deltoid muscles (patient 2) is shown in Figure 6. The patient was 50 years old, male, with the left shoulder so painful that he was

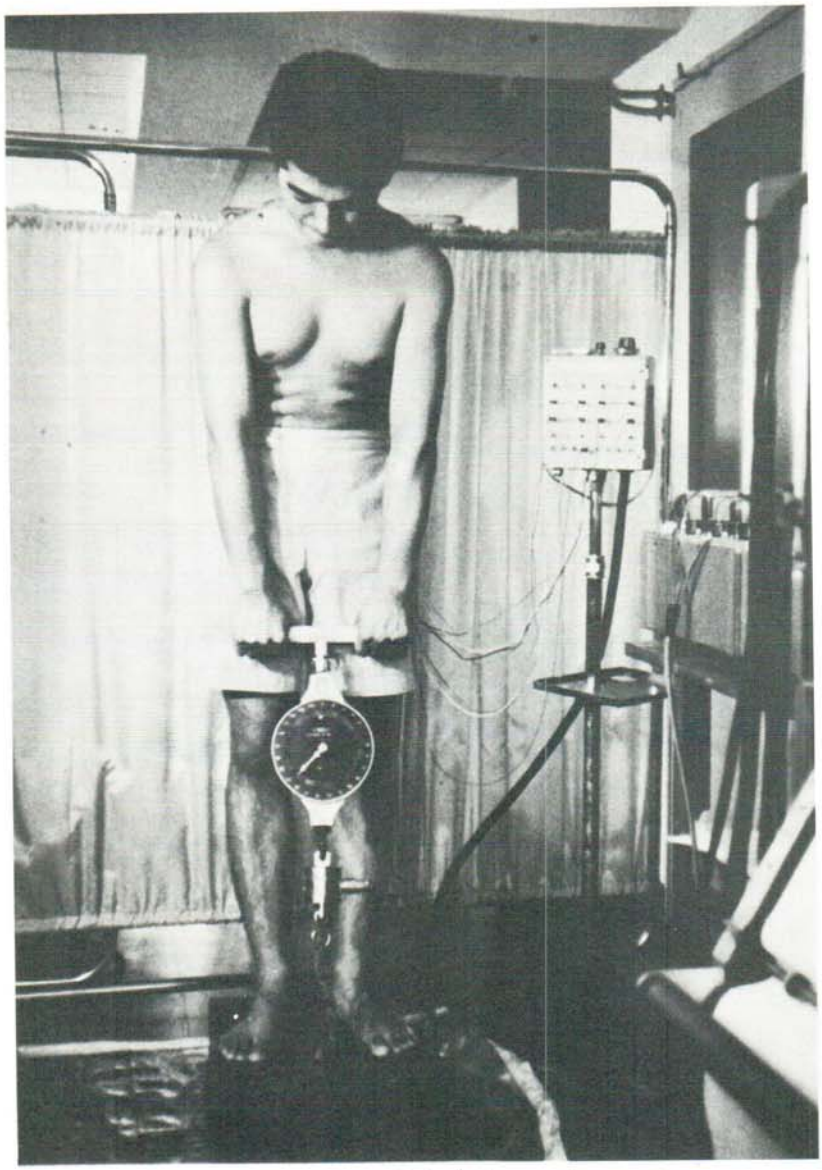

FIG. 4 – Measurement of the back muscular strength.

unable to lift his arm to a horizontal position. Figure 6 shows the measurements of the upper trapezius and deltoid muscles. Back muscular strength was 55 kg, or about one half of an average healthy male of his age. The painful muscles in the left shoulder were stiff and showed wide myogram amplitudes. The left

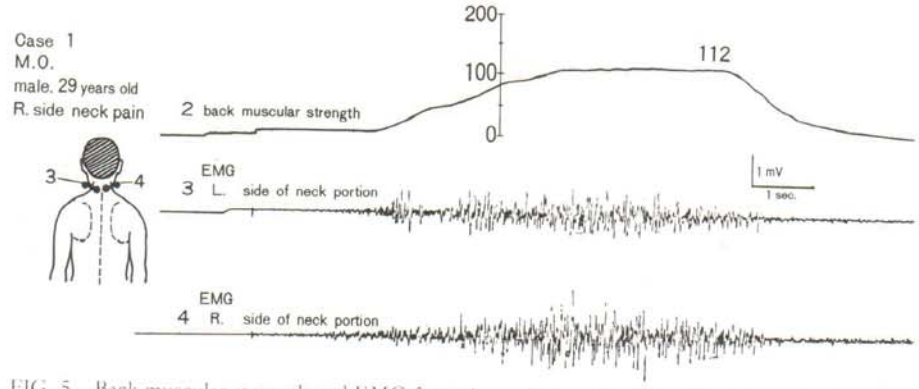

FIG. 5 Back muscular strength and EMG from the neck portion of a patient with right side neck pain.

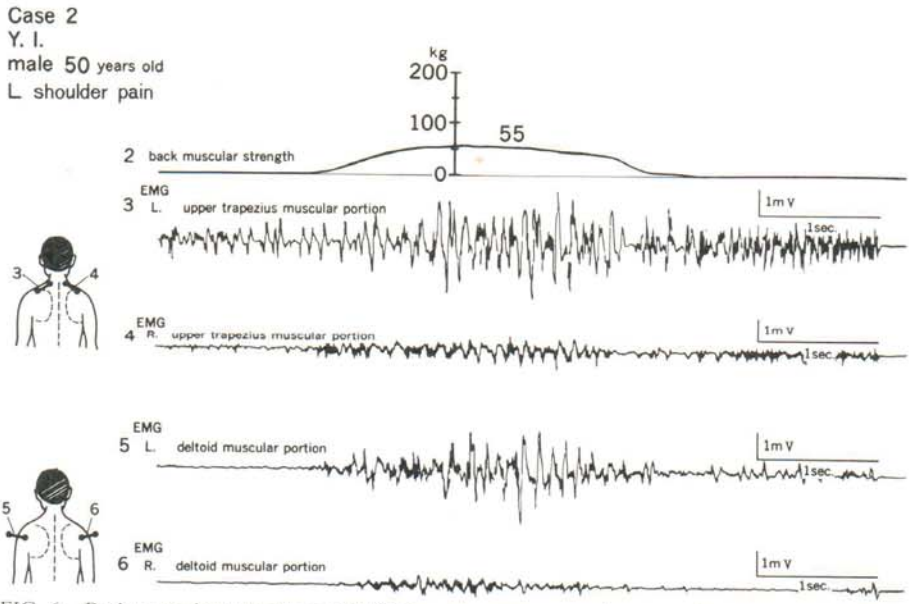

FIG. 6 – Back muscular strength and EMG from the upper trapezius muscular portion and deltoid muscular portion of a patient with left shoulder pain.

myogram amplitude (channel 3) was about 4 times larger than that of the right myogram amplitude (channel 4), and about 5 times larger in channel 5 compared to channel 6.

MSMG of the back muscles (patient 3) is shown in Figure 7. The patient was 27 years old, male, with back pains on the left side. Back muscular strength was 115 kg. The myogram amplitude of the inside portion of the left scapula

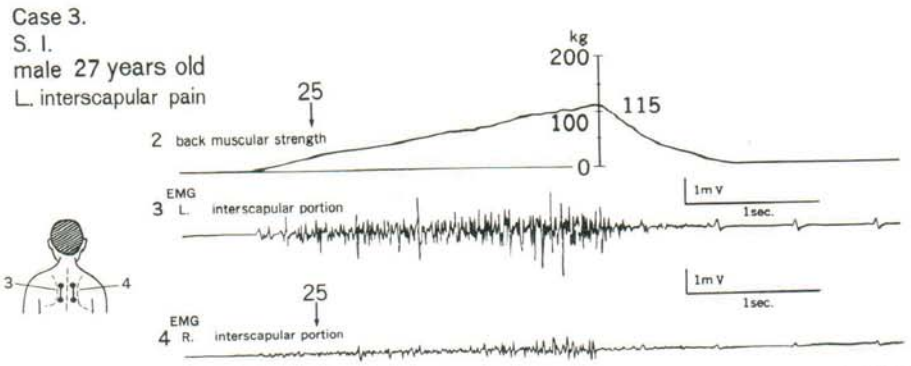

FIG. 7 – Back muscular strength and EMG from the interscapular portion of a patient with left interscapular pain.

where pain was present (channel 3) was about 4 times as large as the right (channel 4).

MSMG of the waist portion (patient 4) is shown in Figure 8. The patient was 39 years old, male, complaining of waist pains with the left side feeling more painful than the right one. The muscles were extremely stiffened. Back muscular strength was 90 kg. The myogram amplitudes changed parallel with the changes in back muscular strength, with the left myogram showing about twice the amplitude of the right.

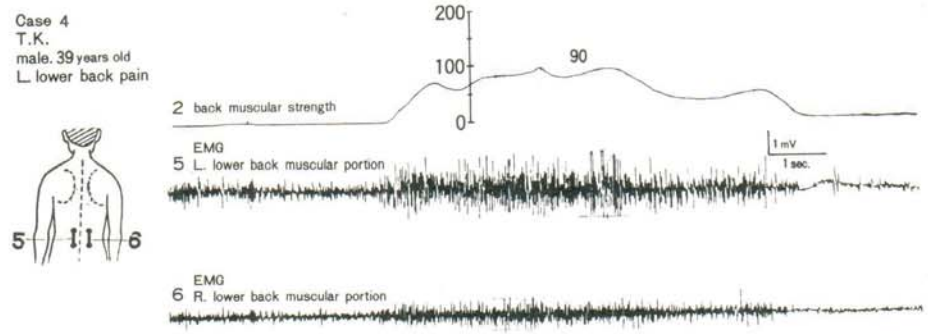

FIG. 8 – Back muscular strength and EMG from the lower back muscular portion of a patient with left lower back pain.

COMPARISON OF AREAS COVERED BY MYOGRAM AMPLITUDE AND BY MUSCULAR STRENGTH CURVE

In order to study the relationship between electric discharge and muscular output, a comparison of the areas covered by myogram amplitude and by back muscular strength curve (abbreviation: AMS ratio)[2], a type of integrating method was sought. In Figure 9, this method was used on a 34-year-old male

who complained of pains in the left shoulder. A comparison of the areas covered by myogram amplitude and by back muscular strength curve showed the ratios of the left side as 1.23 and of the right side as 0.48. This indicates that the side with pain showed a much greater AMS ratio.

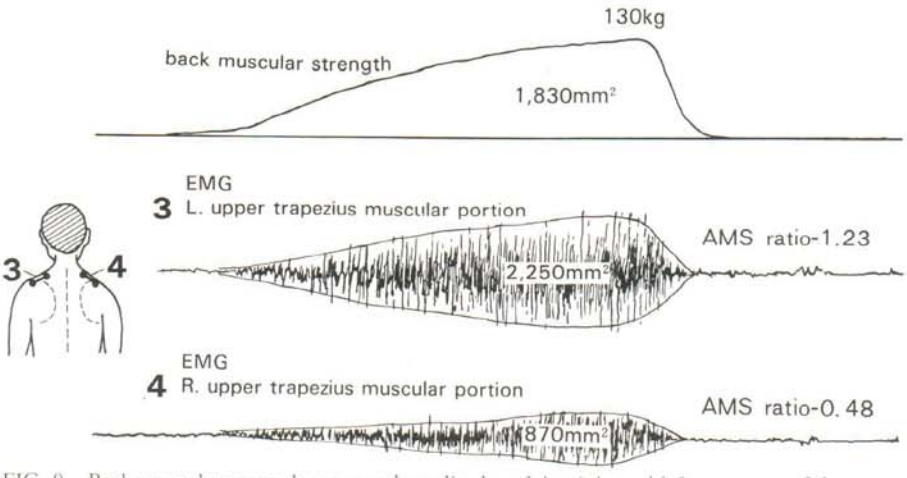

FIG. 9 – Back muscular strength curve and amplitudes of the right and left myogram of the upper trapezius muscular portion. Male, 34 years old with left shoulder pain.

When a group of people with pain was compared to a group without pain by means of the AMS ratio method, as seen in Table 1, the AMS ratio for both males and females of the former group averaged about twice that of the latter group in neck, shoulder, back and waist portions, clearly showing a big difference.

TABLE 1
Comparison of groups with and without pain

		With pain (A)			Without pain (B)			A/B
		N	$\bar{X}$	S.D.	N	$\bar{X}$	S.D.	
Male	Neck-side portion	17	0.69	0.28	88	0.34	0.23	2.03
	Upper trapezius muscular portion	42	1.95	0.92	63	1.12	0.77	1.74
	Interscapular portion	31	1.26	0.60	66	0.70	0.30	1.80
	Lower back muscular portion	29	1.69	0.70	68	0.78	0.42	2.17
Female	Neck-side portion	10	1.15	0.80	86	0.60	0.45	1.92
	Upper trapezius muscular portion	45	2.84	1.45	51	1.74	1.17	1.63
	Interscapular portion	22	1.95	0.87	54	0.97	0.48	2.01
	Lower back muscular portion	28	2.13	1.18	48	1.25	0.83	1.70

XY CORRELATION METHOD AND CASES OF MEASUREMENT

The XY correlation method is one used to record the relationship between myogram amplitude changes and muscular output. Using X-axis representing muscular output and Y-axis representing myogram amplitude with a time constant of 0.1 second, a curved line is produced.

The upper chart in Figure 10 is the myogram of a male patient with pains in the right shoulder, and the lower chart is an XY correlation record of this. The pull action (to the right) and return action (to the left) in the XY chart is

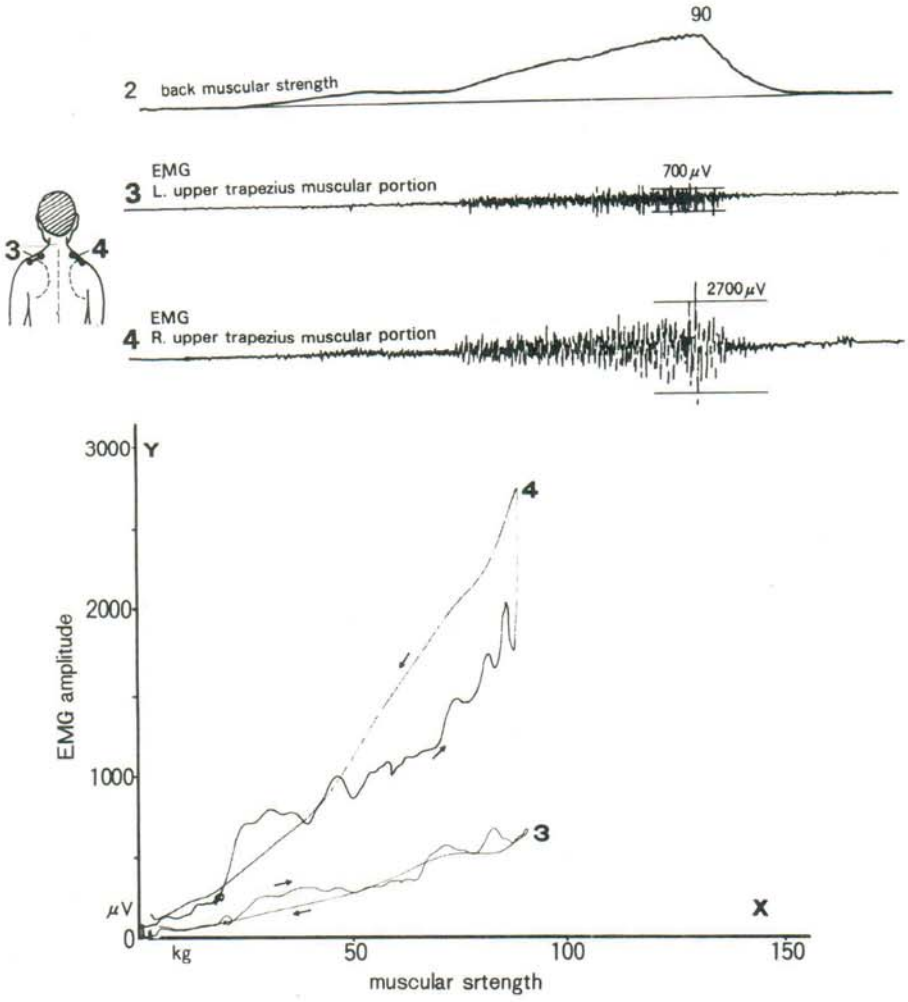

FIG. 10 – XY relation curve between muscular strength and myogram amplitude. Y.M., male, 34-year-old with right shoulder pain.

indicated by arrows. The pull curve advances in wave form in response to the changes in myogram amplitude, while the return action shows a smooth curve. Back muscular strength was 90 kg and the widest amplitude was 700 μV, channel 3 (left) and 2 800 μV, channel 4.

Figure 11 represents the MSMG of a male suffering from right shoulder pains. Compared to the patient in Figure 10, this patient's condition was severer, with a back muscular strength of only a low 40 kg. Myogram amplitudes were 1 000 μV, channel 3 (left) and 2 300 μV, channel 4 (right).

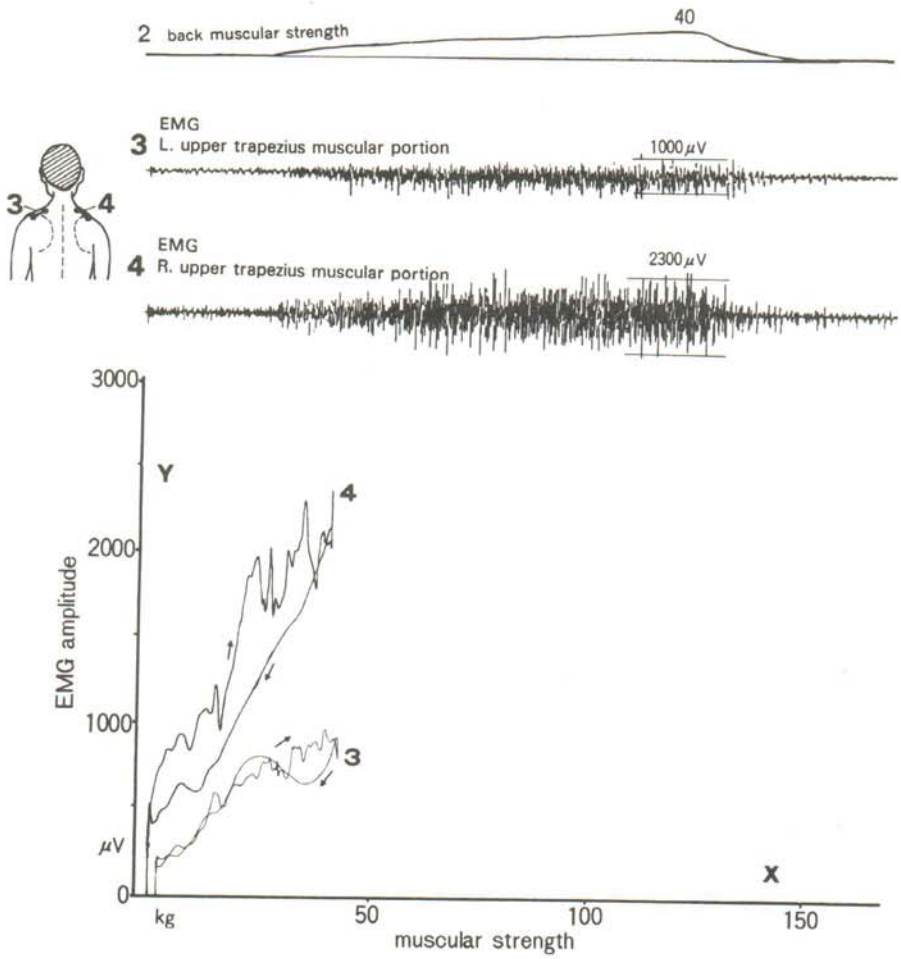

FIG. 11 – XY relation curve between muscular strength and myogram amplitude. H.O., male, 50 years old with right shoulder pain.

The XY charts of both Figure 10 and Figure 11 show the painful side (channel 4) to be closer to the Y axis with steep curves. The curve in Figure 11 is much steeper and closer to the Y axis than in Figure 10, indicating the more serious condition of the patient.

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1. *Konno, Y.* Studies on muscular strength myogram (1). Jpn. J. Ind. Health, **18** (1976) 383–390.
2. *Konno, Y.* Studies on muscular strength myogram (2). Jpn. J. Ind. Health, **20** (1978) 94–104.