Kawasaki Med. J. Vol. 4: No. 4, 307-315, 1978

A TRIAL OF GRADING MYOPATHY BY EMG ANALYSIS AND ITS CLINICAL USE

Nobuyuki DOHI

Department of Rehabilitation Medicine
Kawasaki Medical School
Kurashiki 701-01, Japan

Accepted for Publication on February 26, 1979

Abstract

Electromyography has been one of the most important ways of diagnosing myopathy. Especially analysis of EMG can yield quantitative informations for its diagnosis. Automatic frequency analysis and wave integration have been in clinical use in our daily outpatient clinic.

EMG recording of 32 myopathy cases were reviewed and 12 healthy subjects were examined. EMG was classified in to 4 types according to its grading by the combination of automatic frequency spectrogram and a value of wave integration. Four types were graded normal, slight moderate, and advanced. This grading of myopathy was useful to follow a course of muscle disease which changed its severity by treatment such as thyrotoxic myopathy, while in such a disease as Duchenne muscular dystrophy, EMG analysis already showed advanced grading at the time when clinical diagnosis became apparent. In these cases application of EMG grading to subclinical stage might be suitable.

INTRODUCTION

The diagnosis of myopathy has been advanced recently in the fields of histochemistry, electromicroscopy, and electromyography.

Electromyography, one of those three methods, plays an important role to make a final judgement as to what type of muscular pathophysiology is going on.

In clinical electromyography we have some impression about the advancement in diagnosis of muscle diseases, however, it is still difficult to tell the severity of muscle damage. To solve this problem we have been taking the advantage of quantitative computer analysis of electromyogram recordings.

In the present investigation, we analyzed normal and pathological electro-

土 肥 信 之

myograms by frequency analizer and integrator, to classify them according to clinical course, in which we aim to establish electrophysiologically the grading of damaged muscles.

METHODS

Equipment and systems to record and analyze electromyogram consists of EMG instruments, frequency analyzer and wave form integrator.

EMG; Medelec type MS6 modular electromyograph was used which provided oscilloscope and amplifier in addition to fiber optic photographic paper read-out device. Coaxial needles were routinely used. In examination subjects were always told to perform maximum contraction to obtain interference patterns of EMG wave.

Frequency analyzer; Medelec FA 6 filter type, 12 band wave-frequency analyzer was used which showed on-line read-out of frequcncy histogram between 150 and 1500 Hz. In several cases EMG waves were recorded in tape recorder and analyzed later data processer for detailed analysis for comparing two types of frequency analysis.

Wave integration; Directly connected Medelec I 6-type integrater was used. All electrical activities from EMG were rectified, then passed through a circuit which accumulated the potential, and showed immediately on oscilloscope. When accumulated potential reached maximum, it reset, so that we knew the integrated electrical activity by reset counts.

Control study; 12 healthy men who showed no neurological defficit were examined. EMG was taken from tibialis anterior muscle, vastus medials of quadriceps muscles, and abductor digiti minimi muscle. In each muscle, at least 5 samples were taken.

Muscle disease cases; Since April, 1973 to August, 1978 we performed 219 cases of EMG examinations in which 32 cases of myopathy were present. These recordings are carefully reviewed. Especially cases which we could follow for a long time were analyzed serially in detail according to its clinical course.

RESULTS

Control study; Mean frequency spectrum in each muscle is shown in Table 1 and Fig. 1. Peak frequency was at 150 Hz, while waves above 800 Hz were scarcely seen. Two types of frequency analysis were compared where almost the same results were obtained. A value of wave integration with standard deviation is given in Table 3.

Myopathy; In myopathy, peak frequency tended to shift to right. In advanced typical cases, peak frequency came on 400 Hz as seen in Table 2 and Fig. 1, which was a case of Duchenne muscular dystrophy. A value of wave

TABLE 1.

Frequency Spectrum (%) Control Group

Frequency	T. A.	QUAD.	ABD. V
150 Hz	20.1%	19.1%	20.4%
185	19.1	19.0	19.9
228	16.8	16.7	17.4
281	11.4	11.1	11.2
347	9.2	9.6	9.9
428	8.2	8.1	8.3
527	6.2	6.3	6.2
656	4.1	4.0	3.6
802	2.3	2.4	2.1
989	1.4	1.3	1.1
1230	0.8	0.8	0.6
1500	0.4	0.4	0.3

FREQUENCY HISTOGRAM

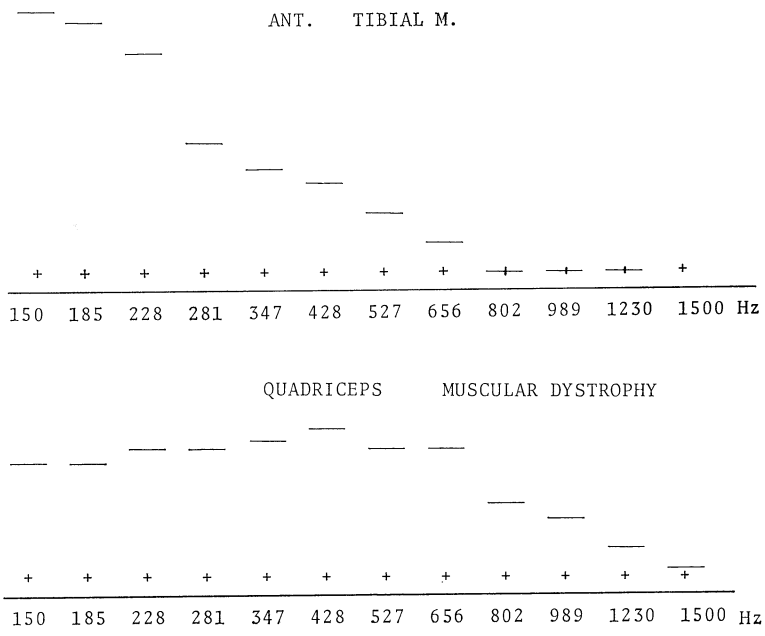

Fig. 1.

TABLE 2.

Frequency Spectrum Muscular Dystrophy

Frequency	QUAD.
150Hz	8.6%
185	8.7
228	10.7
281	9.7
347	11.1
428	11.5
527	9.8
656	9.9
809	6.8
989	5.7
1230	4.1
1500	3.4

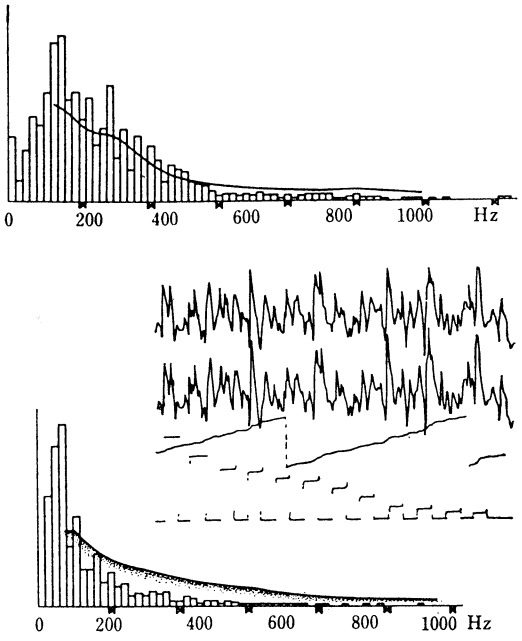

Fig. 2-1. Power spectrum from abductor muscle of little finger (top) and anterior tibial (bottom). Two methods of frequency analysis show almost the same spectrum.

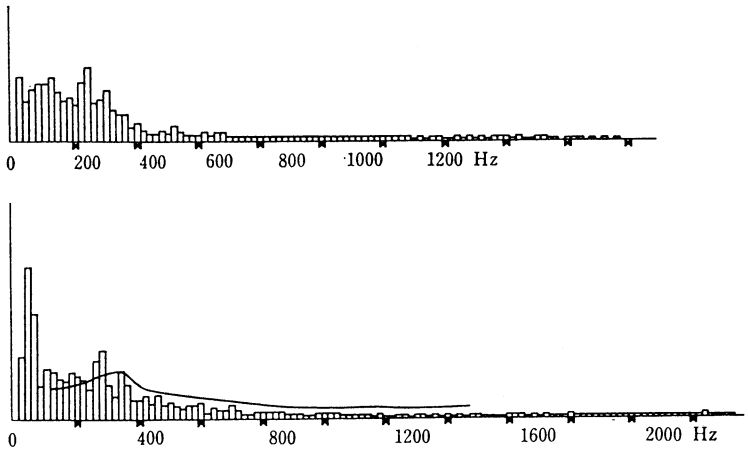

Fig. 2-2. A case of thyrotoxic myopathy (top) and steroid myopathy. High frequency discharge above 1000 Hz is noted

TABLE 3.

Electrical activity (integral)

Anterior Tibial Muscle	41.7±26.7 (n=44)
Quadriceps (V. med.)	28.4±18.2 (n=33)
Abductor (little)	42.5±14.3 (n=29)

μVsec/sweep, 180sec.
coaxial needle

integration in advanced myopathy fell out of standard deviation. In consequence it was obvious that, in myopathy the peak frequency shifted to right and a value of wave integration decreased.

Then in order to judge the severity of myopathy, the shape of frequency spectrum was classified into 4 types as in Fig. 3; they were normal, slight, moderate and advanced grade. In slight and moderate grade, low frequency components remained. While in advanced myopathy they diminished and high frequency components, which could not seen in normal EMG, appeared.

Next step was to analize wave integration. When a value of wave integration was less than 1/2 standard deviation, the grade was advanced by one, and in the same way, when less than 1 standard deviation, the grade was advanced by two (Table 3). Then grading became complete.

Fig. 4 shows relation of clinical course of thyrotoxic myopathy and myopathic gradings. Grading was approaching definitely to normal grade after treatment.

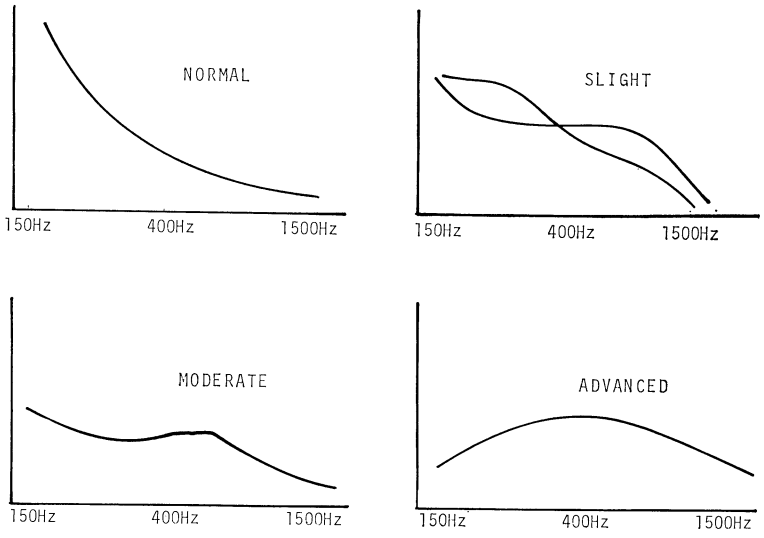

Fig. 3. Grading of frequency histogram

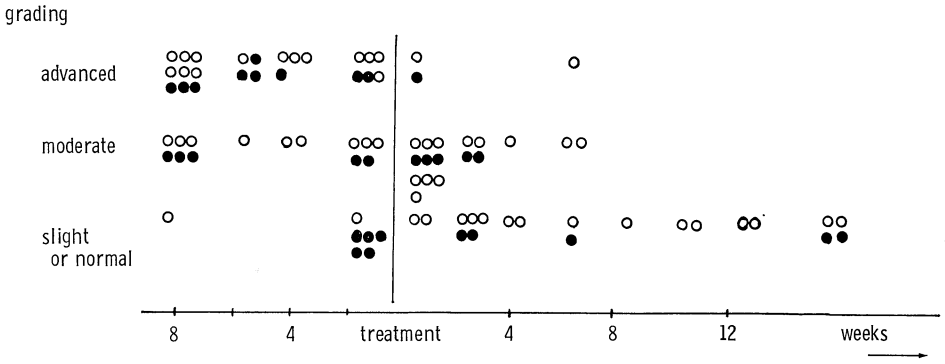

Fig. 4. Myopathy gradings and clinical course before and after treatment.

We had an impression that muscular strength had some relationship with myopathic gradings, however, it was difficult to evaluate the muscular strength in detail by manual muscle testing which was considered not enough to find the minimal change of muscular strength. We consider the grip strength seems to be rather suitable for the evaluation of muscular strength even though in myopathy selective damage and weakness of proximal muscles is said to be the rule (Table 4).

TABLE 4.
Increase of grip strength accompanied by improvement of myopathic grading

0-10Kg	8 cases
10-20Kg	4 cases
20-30Kg	5 cases
10-40Kg	4 cases
40-50Kg	1 cases
more than 50Kg	1 cases

DISCUSSION

Since Adrian and Bronk used coaxial needle electrode in 1929, many authors have proposed various ways to analyze electromyogram. EMG waves can be analyzed by its form, duration, amplitude and discharge frequency. However, direct measurement of these factors require much time consuming works to be of clinical use. In 1951, Richardson suggested that frequency analysis would make possible the diagnosis of myopathy by dividing frequency above and below 400 Hz. This is so far as we know, the first paper about the automatic frequency analysis. In 1952 Walton developed filter type frequency analysis and reported the increase of high frequency components in myopathic muscle.

Integration of EMG wave was also developed by Lipold (1952) and Mason (1969). They tried to measure muscle tension quantitatively. However, a relation between the integrated electromyogram and the tension was linear only in limited conditions. Nowadays it is said, by many authors, that it can be linear when tension is low, but as tension reaches maximum, it is no longer linear. Therefore, the wave integration alone does not seem to give us much information.

Other analysis and the analysis by combination by these methods have been proposed by Fitch (1976), who used spike counting method. His method is useful for differential diagnosis of myopathy and neuropathy. Kunze (1968) developed computer systems directly connected with EMG, which enabled him on-line read-out of wave analysis. These systems mentioned here are used for differential diagnosis of neurogenic disease and myogenic disease.

In general, characteristic electrical changes in myopathy are, 1, the considerable diminution in wave duration, 2, the polyphasic units of which the total duration does not exceed that of normal motor unit, 3, diminished peak to peak amplitude, and 4, the presence of a total interference pattern at the phase of activity far less than maximal effort. Therefore, when we examine

typical myopathic muscle, peak of frequency spectrum shifts to right and a value of wave integration diminishes (Table 5).

TABLE 5.
EMG findings in myopathy

1)	short duration
2)	polyphasic configuration
3)	low peak to peak amplitude
4)	greater firing rate & recruitment

In this paper we have proposed to grade myopathy by combination of frequency spectrum and the value of wave integration of interferenced electromyogram. Cases of thyroid myopathy were chosen for the application in our grading, because this muscular disease can be treated within a relatively short period of time so that we can follow its clinical course and EMG changes serially. After rescinding the influence of thyrotoxic effect completely by surgical subtotal removal of thyroid gland, the grade progressed towards normal gradually. In other myopathic diseases such a muscular dystrophy, EMG change had shown typically myopathic pattern, when the clinical course seemd to be the beginning of the disease. We suppose that electrophysiological change starts and reaches its maximum by far earlier than its clinical onset. It might be worthwhile to examine and grade the EMG when we suspect the early stage or subclinical stage of muscular dystrophy. Further-more this could be used to study the carrier state in the muscular dystrophy, although Gardner-Medwin has already shown the possibility of finding out the carrier by other method of EMG analysis.

We consider it necessary to conduct further study on clinical case and to compare such grading to other myopathic diseases.

Acknowledgment

The author is greatly indebted to Dr. K. Akashi (Dept. of Rehabilitation Medicine) and Dr. T. Harada (Dept. of Endocrine Surgery) for participating in this study.

REEFRENCES

1) Panayiotopoulos, C. P.: Muscular dystrophies and motoneuron diseases, Neurology **26**: 721-725, 1976
2) Pearson, C. M.: The UCLA Interdepartmental Conference, Skeletal Muscle; Annals of Internal Medicine **67**: 614-650, 1957
3) Goodgold, J.: Electrodiagnosis of neuromuscular disease, Baltimore, The William & Wilkins: 116-138, 1972
4) Adrian E. D.: The discharge of impulses in motor nerve fibers, J. of Physiol. **67**: 119-151, 1929
5) Richardson, A. T.: Newer concepts of electrodiagnosis, ST. Thom. Hosp. Rep. **7**: 164-174, 1951
6) Walton, J. N.: The electrical myogram in myopathy; Analysis with the audio-frequency spectrometer, J. Neurol. Neurosurg. **15**: 219-226, 1952
7) Fex, J.: Some experiences with Walton's frequency analysis of the electromyogram, J. Neurol. Neurosurg. Psychiat. **20**: 178-184. 1957
8) Lippold, O. C. J.: The relation between integrated action potentials in human muscle and its isometric tension, J. Physiol. **117**: 492-499, 1952
9) Masor R. R.: Relationship between EMG potentials and tension in abduction of the little finger, Electromyography **9**: 195-199, 1969
10) Willison R. G.: Analysis of electrical activity in healthy and dystrophic muscles in man, J. Neurol. Neurosurg. Psychiat. **15**: 219-226, 1952
11) Fitch, P.: An analyzer for use in human electromyography, Electronic Engineering **39**: 240-243, 1967
12) Lenman, J. A. R.: Quantitative electromyographic changes associated with muscular weakness, J. Neurol. Neurosung. Psychiat. **22**: 306-310, 1959
13) Rose, A. L.: Quantitative electromyography using automatic analysis; studies in healthy subjects and patients with primary muscle disease, J. Neurol. Neurosurg. Psychiat. **30**: 403-410, 1967
14) Grob, D.: Myopathies and their relation to thyroid disease, New York State Journal of Medicine, **15**: 218-228, 1963
15) Logothetis, J.: Neurologic and muscular manifestations of hyperthyroidism, Archives of Neurology, **5**: 533-544, 1961
16) Gardner-Medwin, D.: Studies of the carrier state in the Duchenne type of muscular dystrophy, J. Neurol. Neurosurg. Psychiat. **31**: 124-134, 1968
17) Fuglsang-Frederiksen, A.: Diagnostic yield of analysis of the pattern of electrical activity and of individual motor unit potentials in myopathy, J. of Neurol. Neurosurg. Psychiat. **39**: 742-750, 1976