Correlation of Electromyography and Muscle Biopsy in Myopathy of Young Age

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Correlation of Electromyography and Muscle Biopsy in Myopathy of Young Age

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Jihoon Chang

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ABSTRACT

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The purpose of this study was investigating the accuracy of electromyography(EMG) compared to muscle biopsy in young myopathic patients. Cases were included if the patient was 18 years and less, and the data of muscle biopsy, EMG, and final clinical diagnosis were available. EMG results were classified into 3 groups: myopathic, neurogenic, and nonspecific group. 62 patients were identified using both EMG and biopsy. EMG showed myopathic findings in 55, and microscopy revealed myopathy in 50 and nonspecific findings in 5. 28 out of 33 showed myogenic EMG findings with a conventional EMG, and the histology revealed myopathy in 24. In comparison, turns/amplitude analysis(TAA) with a conventional EMG detected myogenic findings in 27 of 29. 26 of these 27 showed myogenic findings in biopsy. We concluded that EMG is useful for the detection of myopathy in young patients. In addition, TAA may be effective when conventional EMG shows nonspecific findings.

Key words : myopathy; electromyography; muscle biopsy; neuromuscular disease; turns/amplitude analysis

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I. INTRODUCTION

Interviews, physical examinations, genetic tests, electrodiagnosis, and muscle tissue biopsies are all used to diagnose neuromuscular diseases. Confirmative diagnoses are typically made based on a combination of various test results. Muscle tissue biopsies have the disadvantage of invasive procedures, compared to genetic testing and electromyography(EMG). Genetic testing and muscle tissue biopsies cannot determine which muscles are affected and obtain information regarding the progression of the disease. Because of these drawbacks, electromyography is critical for the diagnosis of muscle diseases. Prior to muscle tissue biopsy, through evaluation of a motor unit, the degree and distribution of muscle disease can be examined. [1-3]

The electro-diagnosis of muscle disease is typically difficult in young patients.

Special attention is required when diagnosing children due to the immaturity of the nervous system, technical errors due to the small size of the subjects, an insufficiency of reference data regarding pediatric cases, and poor cooperation muscle relaxation and gradual contraction.[4] The concordance rate between the electrodiagnostic results and the final diagnosis is generally low in young patients. Accuracy is also lower in children who have muscular diseases compared with those who have neurological disorders.[5] In previous studies of evaluating floppy infants, the concomitant use of needle EMG with neuromuscular conduction tests was helpful for differentiating a central nervous system abnormality from a peripheral nervous system abnormality. It was also useful for ruling out the possibility of neurogenic disorder.[6] The primary use of electrodiagnosis would be helpful in pediatric patients who are suspected to have neuromuscular disease or floppy infant syndrome.

Interference pattern analysis is helpful for diagnosis of myopathy. But in patients who cannot be collaborated easily such as children in contracting muscle of minimal degrees, we hardly can not acquire enough data for analysis of interference pattern. Quantitative analysis of the interference pattern based on needle EMG is used as the diagnostic method for neuromuscular disease because it can be easily performed in patients who are not well collaborated when compared with a conventional analysis of the motor unit action potential.[7] TAA reflects the motor units which are induced in an entire range of force.[8] It is useful for assessing muscle activity, muscle fatigue, chronic myalgia, and abnormal muscle contractions after

botulinum toxin injections. Errors between the tester and the laboratory can be minimized, and differences in results based on disease evolution in the same patient can also be determined with TAA.[7-8] TAA has been reported useful in diagnosis of various myopathy.[9-10] In this study, data from young patients who underwent both muscle tissue biopsy and electrodiagnostic testing were analyzed in order to determine the accuracy and usefulness of electrodiagnostic tests. By comparing conventional and quantitative EMG, we were able to assess the accuracy of TAA and whether or not it was useful for making a diagnosis.

II. MATERIALS AND METHODS

1. Subjects

During the period ranging from 2002 to 2009, 62 young patients (ages were 18 years and less) who were suspicious of myopathy and underwent muscle tissue biopsy and electromyography at Gangnam Severance Hospital, Seoul, Korea. The patients who were found to have neurogenic disorder, musucular dystrophy, and inflammatory myositis were enrolled in this study. Only subjects with normal nerve conduction studies were included, and the needle EMG was necessity for diagnosis.

2. Electromyography

EMG were performed for all patients with suspected myopathy before muscle biopsy. All tests of EMG were performed by a single physician who was not aware of the final diagnosis under the supervision of physicians who have more than ten years of experience conducting EMG and are members of American Board of Electrodiagnostic Medicine. The EMG equipment that was used for the evaluation of all enrolled patients was made by Synergy (Oxford Medelec, Wiesbaden, Germany).

Nerve conduction studies included two sensory and two motor in upper extremities and one sensory and one motor in lower extremities at least. Amplitude, latency and conduction velocity of the compound muscle action potentials and sensory nerve action potentials were recorded. These were compared to standard table of reference values in our EMG laboratory. The subjects had the nerve conduction parameters within normal range.

Monopolar needle (TECA Corp., Pleasantville, NY, USA) electormyography was performed in one or two muscles in each upper and lower extremity, selecting preferentially those with mild to moderate clinical weakness. When turns/amplitude analysis is performed, the concept of a cloud is used.[11]

The patterns of muscle contractions in the biceps brachii and tibialis anterior were observed and analyzed for the quantitative analysis of the interference pattern. The range of the filtering frequency was set at 10 Hz for the low frequency filter and 10 KHz for the high frequency filter. The sweep duration was

500 msec. The patterns of muscle contractions in the biceps brachii and tibialis anterior were observed and analyzed for the quantitative analysis of the interference pattern. The muscle contraction was increased gradually in a stepwise manner and the induced interference pattern was obtained. The interference pattern was obtained at least 20 times in each muscle. The resting period was set at several seconds in order to reduce fatigue between contractions.[12] In order to vary the location of the needle and prevent overlapping interference, we progressed EMG needle anterior to posterior or left to right at a minimal displacement of more than 5 mm. The tests were performed at three to five sites per muscle.[13]

The turns per second versus the mean amplitude are plotted during three to five steps of gradual muscle contraction on multiple sites of a tested muscle.

Based on the EMG, the patients were divided into three groups: the myopathy group, the neurogenic disorder group, and the non-specific group. Myopathy was defined as the presence of abnormal spontaneous activity at rest. The typical findings of the conventional needle EMG are shown(Fig. 1).

EMG findings of myopathy were typically characterized by a low amplitude and polyphasic motor unit potential with a short duration, and the occurrence of complete recruitment following a low to moderate degree of effort. A disorder of myopathic origin on TAA was defined as more than 10% of the plots of the turns per second versus the mean amplitude being downward from the reference cloud after more than 20 plots.[11] A neurogenic disorder was defined as the presence of abnormal spontaneous potentials during the resting phase. High amplitude

polyphasic motor unit potentials with a long duration were typically present. A disorder of neuropathic origin on TAA was defined as more than 10% of the plots of the turns per second versus the mean amplitude being upward from the reference cloud after more than 20 plots. Non-specific cases were defined as having normal EMG findings, radiculopathy findings, and cases where a definite diagnosis was impossible. In order to establish reference values for the cloud, we used methods described by Stålberg et al. We measured the conversion point, amplitude, activity, limit frequency, and the number of phases. The tests were performed on the biceps brachii and tibialis anterior of normal healthy people at our EMG laboratory.[14]

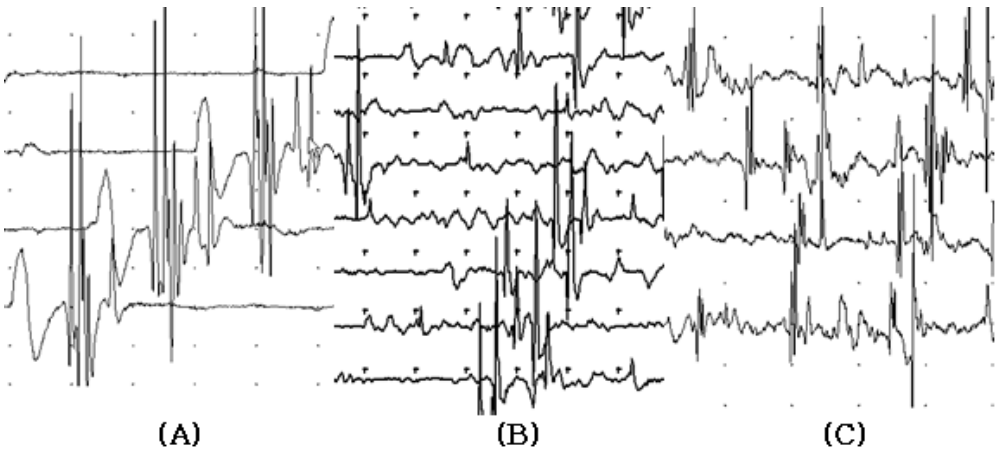

Figure 1. The figures are typical findings of the conventional needle EMG in neurogenic (A), normal (B) and myogenic disease(C). Sweep speed was 100ms and gain was 10μv/div.

Furthermore, in order to examine the accuracy of an additional TAA, a comparison was made between a conventional EMG(needle EMG with nerve conduction study) and a TAA(turns/amplitude analysis with conventional EMG). A conventional EMG was defined as a needle EMG with a nerve conduction study but no additional TAA.

3. Muscle biopsy

Open muscle biopsies were performed from vastus lateralis by an orthopedic surgeon at Gangnam Severance Hospital. The muscle biopsy samples were interpreted by 2 pathologists and a neurologist. The results were then classified into three groups; the myopathy group, the neurogenic disorder group, and the non-specific group. Muslce specimens were stained with hematoxylin-eosin, periodic acid-Schiff, trichrome, reduced form of nicotinamide-adenine dinucleotide, adenosine triphosphatases(pH 9.4, 4.6, 4.2).

4. Statistical analysis

A statistical analysis of the data was performed using SPSS 12.0 for Windows. A Fisher's exact test was used to verify that there were the differences of the specificity and sensitivity, depending on the difference of the test methods between the two groups.

III. RESULTS

A muscle tissue biopsy and an EMG were performed in a total of 62 patients. These patients included 15 females and 47 males and their ages ranged from 1 month to 18 years(Fig. 2). The final diagnosis of enrollred patients were Duchenne muscular dystrophy, Becker muscular dystrophy, congenital myopathy, dermatomyositis and so(Table 1). All nerve conduction velocities of 62 patients were within normal range which were adjusted to their ages.

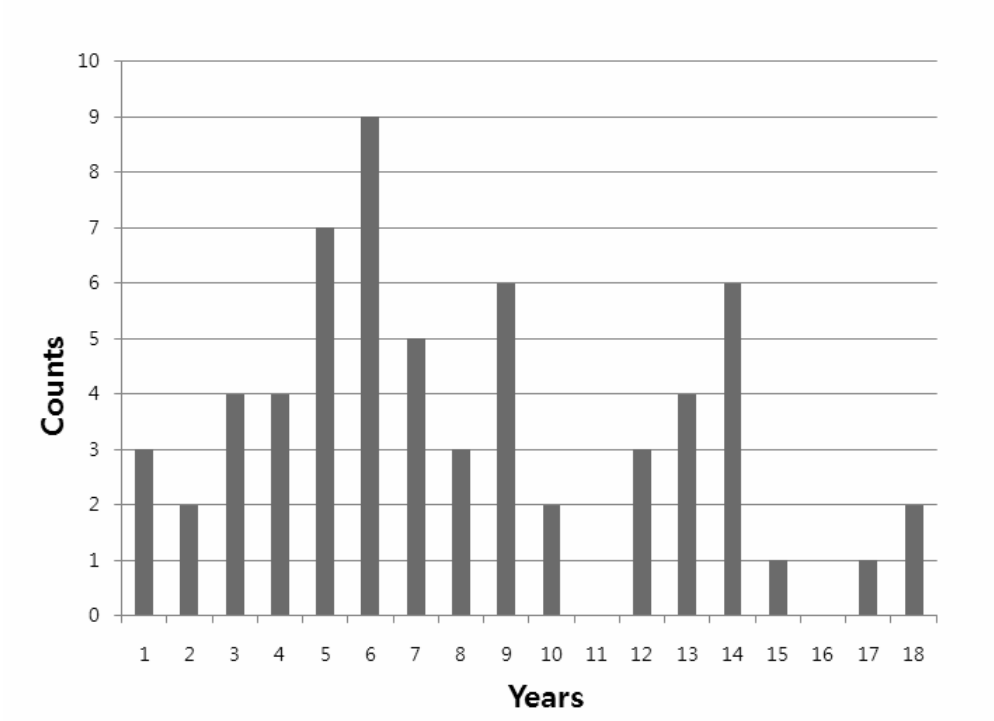

Figure 2. Age histogram of the recruited patients.

Table 1. Final diagnosis of myopathic patients.	
Duchenne muscular dystrophy	27
Becker muscular dystrophy	1
Congenital myopathy	9
Limb girdle muscular dystrophy	6
Dermatomyositis	4
Unspecified	4
Totals of myopathic patients	51

55 of the 62 patients who underwent EMG had findings suggestive of myopathy. Two patients had findings suggestive of neurogenic disorder. Five patients did not have findings of either myopathy or neurogenic disorder (Table 2).

Table 2. Comparison of electromyography and final diagnosis.

		Final diagnosis		
Electromyography	Totals	Myopathy	Neuropathy	Nonspecific
Myogenic disorder	55	50	0	5
Neurogenic disorder	2	0	2	0
Nonspecific	5	1	1	3

50 of the 55 patients who had findings suggestive of myopathy on EMG were diagnosed with myopathy based on a muscle tissue biopsy. There were no notable findings on a tissue biopsy in the other five patients.

One of the five patients who had no notable findings on the EMG was diagnosed with myopathy based on a tissue biopsy. One was diagnosed with neurogenic disorder, and three had non-specific findings on a tissue biopsy.

27 of the 51 patients who were diagnosed with a myopathy were found to have Duchenne's muscular dystrophy. One had Becker's muscular dystrophy. Nine had a congenital muscular dystrophy. Four had dermatomyositis. Six had limb-girdle muscular dystrophy. Four patients had an unidentified muscle disease. There were three patients with a neurogenic disorder, and eight patients with non-specific findings based on the muscle tissue biopsies.

The sensitivity and specificity of EMG in the diagnosis of muscle disease were found to be 98.0% (95% (CI): 89.5-99.9%) and 54.5% (95% CI: 23.3-83.2%). A total of 33 patients underwent only a conventional EMG. Conventional EMG included neelde EMG. Based on those EMG, 28 patients had a myopathy, one had a neurogenic disorder, and four had non-specific findings (Table 3). 24 of the 28 patients who had a myopathy on a conventional EMG were diagnosed with a myopathy based on a tissue biopsy. However, four had no abnormal findings on a tissue biopsy. When a conventional EMG was used to diagnose a myogenic disorder, the sensitivity was 96% (95% CI: 79.6-99.9%) and specificity was 50% (95% CI: 15.7-84.3%).

Table 3. Comparison of conventional electromyography and final diagnosis.

		Final diagnosis		
Classical electromyography	Totals	Myopathy	Neuropathy	Nonspecific
Myogenic disorder	28	24	0	4
Neurogenic disorder	1	0	1	0
Nonspecific	4	1	1	2

A total of 29 patients were given an additional TAA. The results of TAA were marked with cloud(Fig. 3). 27 were found to have a myopathy. One had neurogenic disorder, and one had non-specific findings (Table 4). 26 of the 27 patients with a myopathy were diagnosed with the myopathy based on a tissue biopsy. One had no abnormal findings on a tissue biopsy. In the patients who had an additional TAA to diagnose a muscle disease, the sensitivity was 100% (95% CI: 86.7-100.0%) and the specificity was 66.7% (95% CI: 0.8-90.5%). There were no significant differences in the sensitivity(p-value=0.49) and specificity(p-value=1) between the conventional EMG and TAA groups.

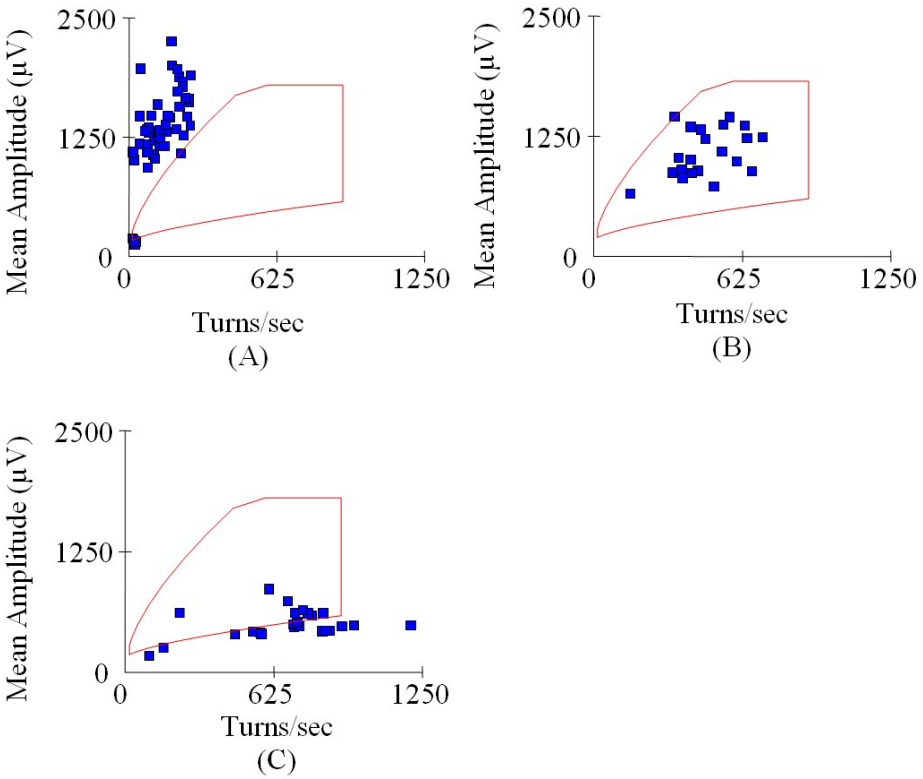

Figure 3. The figures are clouds of neurogenic(A), normal(B) and myogenic values(C) of amplitude versus turns/sec in male biceps brachii for turns/amplitude analysis.

Table 4. Comparison of turns/apmlitude analysis and final diagnosis.

		Final diagnosis		
Quantitative electromyography	Totals	Myopathy	Neuropathy	Nonspecific
Myogenic disorder	27	26	0	1
Neurogenic disorder	1	0	1	0
Nonspecific	1	0	0	1

In regards to the TAA, there were four patients in whose conventional EMG we could not find any abnormal spontaneous activities even in muscle resting phase, and the age of these children are 49, 61, 65, 113 in months. In these patients, through TAA myopathic findings in turns-amplitude were revealed through TAA. Based on the tissue biopsies and clinical manifestations, four patients were diagnosed with a myopathy. Three of these patients were diagnosed with a Duchenne muscular dystrophy, and one was diagnosed with a limb-girdle muscular dystrophy. And a child with myopathic findings of conventional EMG was diagnosed as normal after TAA. This child age was 151 in months, and conventional EMG showed some polyphasic short amplitude motor units and a few denervation potentials. But additional TAA and muscle biopsy result were normal.

IV. DISCUSSION

In this study, EMG and muscle biopsy were performed in young patients who were clinically suspected to have a muscle disease. A comparison was made between cases in which a TAA was performed and it was not for examining whether the diagnostic rate for muscle diseases would rise if a TAA was performed. In patients with a myopathy, there was a tendency for the diagnosis to be more accurate when a TAA was performed.

In this study there were seven patients in whom there was a discrepancy between

the EMG findings and the results of a tissue biopsy. Two of these patients had non-specific EMG findings. One was ultimately diagnosed with a congenital myopathy based on a muscle biopsy. Another was diagnosed with neurogenic disorder. Five patients who had findings suggestive of a myopathy on an EMG shows nonspecific biopsy findings.

The mean age of the patient group in which the EMG findings and the results of a tissue biopsy were congruent was 87 months and the median was 74 months. In seven patients in whom there was no consistency between the EMG findings and the results of a tissue biopsy, the mean age was 118 months (37-167 months). There was no significant difference in the mean age between the two groups. Due to the technical difficulties of performing an EMG in young patients, it was expected that the mean age would be lower in the group where there was no consistency between the EMG findings and the results of a muscle biopsy. However, in this study there was no significant difference in this series. This may be because the results originated from a smaller number of enrolled patients.

An analysis of the interference pattern based on the TAA reflects the motor unit which was induced by all degree of the forces. This means that we were able to record signals formed by the involvement of action potentials of all types of motor units. Patient compliance is a relatively less important factor for TAA than for traditional interference pattern analysis. Signals can be obtained faster, and the data can also be processed faster. This can be helpful for young patients in whom there was insufficient extent of collaboration and in whom a small magnitude of force

could not be induced. The electrical activity of a muscle contraction should be analyzed while the subject is contracting the muscle. This is especially important in patients who have impaired cognition or paralysis and show poor compliance during an EMG, or those who were unable to exhibit gradual muscle contractions. There are limitations in the classical analysis of the motor unit and interference patterns.[14]

In this study, TAA was decisive for 5 patients. In 4 patients in whom we could not conlude myopathy with conventional EMG, TAA showed myopathic findings. And TAA helped us to conclude normal in 1 patient. In 2 patients of previous 4, low collaboration made the analysis of the motor unit difficult. In the other two patients of previous 4, abnormal EMG findings could not be detected when we used a conventional EMG alone. Following the additional use of a TAA, the results of an EMG analysis corresponding to a myopathy could be obtained.

V. CONCLUSION

In this study, there was more consistency between the EMG findings and a muscle tissue biopsy when making the diagnosis of a myopathy compared to previous report.[5,15] In Korea, there were no previous studies that compared EMG findings and tissue biopsies

An EMG is a test that is expected to accurately diagnose muscle disease. However, successful administration of EMG tests requires patient cooperation. A TAA could

be helpful for making a diagnosis of a muscle disease in pediatric patients whose cooperation is poor.

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ABSTRACT(IN KOREAN)

유아청소년 근육병 환자에서
근전도 검사와 근육 생검 간의 정확도 비교

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장 지 훈

근육병 환자의 진단에 근전도가 많이 사용되고 있다. 본 연구는 특히 젊은 근육병 환자의 진단에서 근전도가 근육생검과 비교 시 얼마나 정확한지를 알아보고자 하였다. 18세 이하의 환자들을 대상으로 후향적 연구를 하였고, 근전도, 근육생검, 임상적 진단의 기록이 있는 환자들을 대상으로 하였다. 근전도 결과에 따라 근육성군, 신경성군, 비특이적군의 세 군으로 분류하였다. 62명 환자들의 근전도와 근육생검 결과를 확인하였다. 근전도 검사에서 근육성인 경우가 55명에서 확인되었고, 이 중 50명의 근육생검 상 근육병성 소견을 보였고, 5명의 근육생검 결과는 비특이적이었다. 고식적 근전도만을 시행하였을 경우 33명 중 28명에서 근육성 소견을 보였고, 이 중 24명의 근육생검 결과가 근육성인 것으로 보고되었다. 반면 정량적 근전도를 추가로 시행한 33명에서는 27명이 근육성 근전도 소견을 보였고, 이 중 26명의 근육생검 결과가 근육성으로 보고되었다. 이 번 연구에서 젊은 근육병의증 환자의 진단 시에 근전도 검사가 도움이 되는 것을 확인할 수 있었고, 고식적 근전도에서 확실한 결과를 얻을 수 없는 경우에는 정량적 근전도를 추가로 시행하는 것이 효과적인 것을 알 수 있었다.

핵심되는 말 : 근육병, 근전도, 근육생검, 신경근육계질환, 정량적근전도