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Analysis of Electroneuromyography Component Result as the Supporting Diagnosis of Carpal Tunnel Syndrome

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Abstract : There are number of diseases that have becoming chronic due to late diagnosis. By becoming chronic, those diseases will become more difficult to treat and lead to high risk of death. Because of this, early detection is considered to be important. One of those diseases is carpal tunnel syndrome. This study focusing on principal component analysis (PCA) results on peripheral nerve conduction. PCA method was conducted to get the structure of motoric and sensory median nerves based on four variables. The level of carpal tunnel syndrome can be measured from the latency, amplitude, nerve conduction velocity (NCV) and Fwave. There is a tendency that high latency correlates to low amplitude and high Fwave correlates to low NCV. Markedly, CTS status is derived mostly from latency and amplitude.
Keywords: electroneuromyography, principal component analysis, median nerves, carpal tunnel syndrome.

Introduction

The disorder happens in peripheral nerves is called as peripheral neuropathy. This affects on the central nerves located in brain and spinal cord, which influencing the work of hands and feet[1]. Nowadays, there are more than twenty millions of elders in America suffering peripheral neuropathy[2]. It becomes worse such as paralysis and disturb sufferer activities if not be treated. Genetic factor, malnutrition, metabolic syndrome, virus infection, inflammation, poisoning, trauma, occupational stress, operation or mechanical factors are believed to be the causes of peripheral neuropathy. Therefore, there are about 100 types of peripheral neuropathy in the worldwide[1,3,4].

Electroneuromyography (ENMG) is a method that is used for the diagnosis of peripheral nerve diseases. This combines the examination of electroneugraphy (ENG) and electromyography (EMG). Electroneugraphy refers to the examination of nerve conduction covering the nerve conduction velocity (NCV) from both motoric and sensoric nerves also the slow respons. In addition, electromyography is the examination of electrical activity of muscle, which identifies the causes of pain or paralysis[5].

Nerve conduction velocity is examined through the stimulation using surface electrode from both motoric and sensoric nerves. The abnormality that will be detected on NCV and evoked potentials can describe the pathophysiology of the peripheral neuropathy. Therefore, the electric activity of the electrode is examined through injection of EMG needle to the muscle. Due to this, the axonal degeneration, denervation and the abnormality on the muscle are detected[5,6].

Basically, ENMG is the specific examination from clinical check-up, where the good results of clinical check-up will limit the other specific examination. By doing this examination, it covers diagnosis from topic, pathology and prognosis on the problem of peripheral nerves and muscles. Beside of that, it will also be detected the lesion on the level of motoric neuron, spinal nerve radix, plexus, peripheral nerve, neuromuscular junction or on the muscle. Otherwise, EMG will only support the diagnose of problem and muscle weakness[5,6].

Material and Method

The observation was conducted to measure latency, amplitude, NCV, Fwave and CTS status. There were 59 subject distributed on healthy or normal group (20), mild CTS (20), moderate CTS (14) and severe CTS (5). Data were analyzed statistically using principal component analysis and multinomial regression. The principal component analysis was to determine the data structure of four variables, while the multinomial regression was used to predict the level of CTS[7,8].

Results

Latency result of normal group is the lowest compare to the other groups, it is 3.12 ms. On the other hand, moderate and severe group have latency 6.31 ms and 7.19 ms respectively, which are much higher than normal group. In addition, mild group is slightly higher than normal group that shows latency 3.67 ms. In spite of this, the amplitude character is contrast from the latency. The low latency is correlated to high amplitude. It is shown in the data where the normal and mild groups have high amplitude 7.33mV and 7.45 mV respectively. Moreover, the other groups (moderate and severe) have low amplitude with average 4.80 mV and 3.56 respectively (Table 1).

Table 1. Descriptive statistics of median motoric CTS

Group	N	Latency	Amplitude	NCV	Fwave
Normal	20	3.12	7.33	58.73	25.41
Mild	20	3.67	7.45	56.20	28.51
Moderate	14	6.31	4.80	54.65	25.61
Severe	5	7.19	3.56	49.92	20.69

In the same way, NCV data shows similar pattern with amplitude data. Normal and mild group have higher NCV (58.73 m/s and 56.20 m/s) than moderate and severe (54.65 m/s and 49.92 m/s). Fwave data also shows the similar pattern with NCV data, which normal and mild group have higher Fwave than moderate and severe groups.

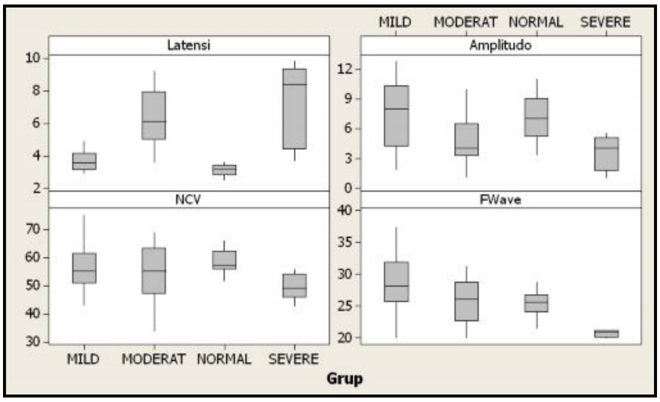

Figure 1. Boxplot of the latency, Amplitude, NCV and Fwave Motoris Medianus

Descriptive Analysis showed that latency, Amplitude, NCV and Fwave Motoris Medianus have different means. The Bloxpot described that outliner data was not identified and data distribution is normal (Figure 1).

Principal Component Analysis (PCA) result:

There are only two variable groups that can describe the data structure of median motoric nerve. The contribution of the first and the second components are 43.8% and 26.8% respectively or 70.6% cumulatively.

Table 2. PCA results of median motoric CTS

Variable	PC1	PC2	PC3	PC4
Latency	-0.674	0.001	-0.038	-0.738
Amplitude	0.595	0.071	0.561	-0.572
NCV	0.358	-0.650	-0.601	-0.297
Fwave	0.253	0.757	-0.568	-0.200
Eigenvalue	1.753	1.071	0.803	0.373
Proportion	0.438	0.268	0.201	0.093
Cumulative	0.438	0.706	0.907	1.000

The first component is dominated by latency (-0.674) and amplitude (0.595). It is indicated that these two variables are inversely proportional, where high latency will be followed by low amplitude level (Table 2). The second component is represented by Fwave and NVC that are also inversely proportional, or high latency will be followed by low NCV. Therefore, PCA result indicates that the main data structures of median motoric nerve are latency and amplitude, where latency tends to inversely proportional with amplitude, Fwave and NCV[7].

CTS prediction with multinomial regression:

Multinomial regression was done into two test, group reference and group outcome. Normal group was analyzed with group reference and the other groups were with group outcome. These analysis resulted three logit functions in order to obtain the probability of the four groups (Table 3).

Table 3. Multinomial Regression

Variable	$G(X_1)$	$G(X_2)$	$G(X_3)$
	Mild	Moderate	Severe
Constants	-26.533	-17.104	7.296
Latency	3.399	7.162	7.222
Amplitude	0.171	0.498	0.606
NCV	0.096	-0.079	-0.131
Fwave	0.313	-0.377	-1.453

Note: $\chi 2 = 82{,}272$; $p = 0{,}000$; $R^2_{Nagelkerke} = 81{,}9\%$

The results of analysis show that the three logit equation are significant ($\chi^2 = 82{,}272$; $p = 0{,}000$) with total contribution 81.9%. The logit equation for each CTS group are as follows:

$G(X_1) = -26{,}533 + 3{,}399\ Lat + 0{,}171\ Amp + 0{,}096\ NCV + 0{,}313\ FW$

$G(X_2) = -17{,}104 + 7{,}162 Lat + 0{,}498 Amp - 0{,}079\ NCV - 0{,}377\ FW$

$G(X_3) = 7{,}296 + 7{,}222 Lat + 0{,}606 Amp - 0{,}131\ NCV -1{,}453\ FW$

Otherwise, the probability of each group is derived from these three logit equation as follows:

Probability (Normal) $= \dfrac{1}{1+e^{G(X_1)}+e^{G(X_2)}+e^{G(X_3)}}$

Probability (Mild) $= \dfrac{e^{G(X_1)}}{1+e^{G(X_1)}+e^{G(X_2)}+e^{G(X_3)}}$

Probability (Moderate) $= \dfrac{e^{G(X_1)}}{1+e^{G(X_1)}+e^{G(X_2)}+e^{G(X_3)}}$

Probability (Severe) $= \dfrac{e^{G(X_1)}}{1+e^{G(X_1)}+e^{G(X_2)}+e^{G(X_3)}}$

As an illustration of examination over the median motoric nerve, with latency 3.44 ms, amplitude 10.92 mV, NCV 55.2 m/s and Fwave 22.52 it will be obtained normal probability 31.4%, mild 15.4%, moderate 39.2% and severe 14.0%.

Conclusion

In summary, the results of PCA analysis can be used to describe the data structure of median motoric nerve based on latency, amplitude, NCV and Fwave. It can be predicted the level of CTS on peripheral neuropathy sufferers by multinomial regression analysis. Patients with high latency and amplitude show low NCV and Fwave, which are the characteristic of severe CTS sufferer. Then patients with high latency and amplitude without low NCV and Fwave are moderate CTS sufferers. Lastly, patients who show high latency with high Fwave are considered as mild CTS sufferer.

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