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Comparative Study of Electromyography and Hand Elevation Test in Carpal Tunnel Syndrome

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Purpose: Since the hand elevation test was first introduced by Ahn in 2001, it has been one of most performing provocative test for diagnosing carpal tunnel syndrome. Although many studies have been published on the hand elevation test, there are no study that can explain why false-negative results of hand elevation test appears in carpal tunnel syndrome patients diagnosed by electromyography (EMG) findings. Therefore we searched out whether hand elevation test is related with EMG severity.

Materials and Methods: We made a retrospective study of 654 bilateral carpal tunnel syndrome patients. Among them 134 were studied which had different hand elevation test results on each hands. The paired samples t-test was used to compare the EMG severity of each group. The relationships between hand elevation test and EMG severity were examined using Pearson-product correlations. Comparing whether the frequency of false negative hand elevation were different between both hands, and whether the severity of EMG depends on which side of hand is, was evaluated with Mann-Whitney U-test.

Results: Severity of EMG in positive group was moderate to severe on average, whereas mild to moderate on negative group, with significant difference statistically ($p<0.001$). Correlation between the hand elevation test results and EMG severity also showed significance statistically ($p<0.001$).

Conclusion: Mild severity of EMG was found out to be the factor affecting the false results. However, EMG severity and hand elevation test shows a meaningful correlation, supporting the value of hand elevation test.

Key Words: Hand elevation test, Carpal tunnel syndrome, Electromyography, Provocation test

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INTRODUCTION

Carpal tunnel syndrome is a disease produced by the compression of the median nerve at the wrist. There are several provocative tests with variable sensitivity and specificity for diagnosing such as Phalen's and Tinel's test. Ahn[1] first introduced the hand elevation method as a new and reliable provocative test for carpal tunnel syndrome. The test was done by simply raising both hands and maintained for up to two minutes. It is thought that when hands are raised, microcirculation of median nerve will be compromised. In carpal tunnel syndrome patients, ischemia of microcirculation will occur more easily due to increased pressure within the carpal canal. When microcirculation is compromised, provocation appears as follows; if the patient felt paresthesia, tingling or numbness in the median nerve distribution area, the test was considered positive as was introduced in detail by Ahn.[1] As the clinical application of this new test increased gradually worldwide, various studies supported the value of the hand elevation test.[2,3] However, as we used this test for more

than 10 years, some false-negative results appeared although it was proved as a reliable provocative test. Therefore this study was aimed to find out whether the severity of electromyography (EMG) is one of the factor that affects the false result of hand elevation test, and proving the correlation between them.

MATERIALS AND METHODS

A retrospective study was performed who were diagnosed by as bilateral carpal tunnel syndrome on both hands, from October 1999 to September 2013. Diagnosis was made by clinical history, physical exam and EMG. Demographic data, hand elevation test results on preoperative evaluation, EMG findings were collected through medical chart review. Patients who had EMG and hand elevation test data on both hands were collected. Total of 654 bilateral carpal tunnel syndrome patient's data were collected. However, we wanted to control other patient dependent factors that can influence on results, therefore patients that had different results of hand elevation test on each hands were only included in this study. Each hands were grouped as positive or negative group, regarding on result of hand elevation test. One hundred thirty-four patients were included in this study, so we had 134 of positive group, and 134 of negative group. Those who had both hands in same results as positive or negative were excluded. Sixty patients showed left hand positive and right hand negative results of hand elevation test, whereas 74 patients showed right hand positive and left negative. Eleven patients were men and 123 patients were women. The mean age of patients was 55.4 years (range, 34 to 81 years) and most patients were in their sixth decade of life.

EMG results ranged from very mild to extremely severe. Severity was rated to score for statistical analysis as follows: very mild=1, mild=2, moderate=3, severe=4, very severe=5, extremely severe=6.

Statistical analysis was performed with IBM SPSS Statistics ver. 20.0 (IBM Co., Armonk, NY, USA). The paired samples t-test was used to compare the EMG severity of each group. The relationships between hand elevation test and EMG severity were examined using Pearson-product correlations. Comparing whether the frequency of false negative hand elevation were different between both hands was evaluated with Mann-Whitney U-test. EMG of the hand which were positive in hand elevation test were compared between whether the hand is left or right. On the other hand, negative hands were also compared as same, all with Mann-Whitney U-test. All results were considered significant at $p<0.05$.

RESULTS

Severity of EMG in positive group was 3.50 (moderate to severe) on average, whereas 2.55 (mild to moderate) on negative group. Positive group ranged from 2 to 6 (mild to extremely severe) and majority was moderate or more severe. On the other hand, negative group ranged from 1 to 4 (very mild to severe) with majority showing mild or moderate. None of more than severe grade showed false negative results. The positive hands of hand elevation test were more severe with significance statistically ($p<0.001$; Fig. 1).

Correlation between the hand elevation test results and EMG severity using the data of 268 both hands also showed significance statistically ($p<0.001$, Pearson $r=0.521$). Hands with more severe degree of EMG had more tendency of positive result of hand elevation test.

The frequency of which hand occurred positive or negative on hand elevation test didn't show difference significantly. Moreover, comparison of the EMG of positive hands, whether it's left hand or right wasn't different significantly, as well as negative hands were also the same. This results show that which hand it was didn't affect on the results.

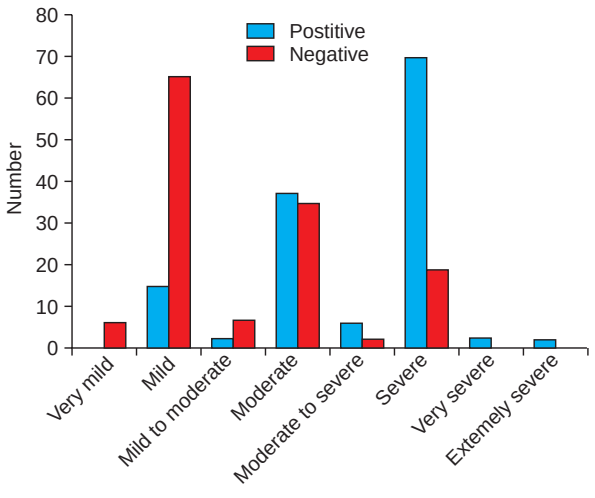

Fig. 1. Distribution of electromyography severity. Two groups showed significant difference statistically ($p<0.001$).

DISCUSSION

Although Tinel's and Phalen's test are commonly used, there is not yet a single definite provocative test for carpal tunnel syndrome. After the senior author introduced hand elevation as a non-inferior or possibly more proficient provocative test,[1] Amirfeyz et al.,[2] Ma and Kim[3] also supported the value of the hand elevation test. However, false negative rates were seen on several studies; 24.5% in Ahn,[1] 12% in Amirfeyz et al.,[2] 13.3% in Ma and Kim,[3] yet more reliable results than Phalen's and Tinel's in those studies.

In our knowledge, there is no study about comparing severity between different hand elevation test results, moreover that can explain the factor that influences to negative results of hand elevation test. Choi and Ahn,[4] Faour-Martín et al.[5] showed relations of EMG and symptoms, and Tahririan et al.[6] investigated only about EMG difference perioperatively.

Our study compared different resulted hands in same person, so the demographics and other medical conditions that can affect on study could be matched as same. Other variables except EMG severity and hand elevation test were all controlled, so pure investigation was made statistically.

In regard to our results, we found out that not only as a diagnostic tool, the hand elevation test was also related to severity of EMG results. Mild severity was the factor that caused false results. Not mentioned in the results, only 7 cases (5.2%) showed that negative hand elevation hand had more severe EMG result than opposite positive hand. Moreover, all but one were only one grade different. This makes connection with correlation between severity and positive tendency of hand elevation test that we proved statistically.

Fig. 1 is just to see the difference between two groups at a look, and it cannot be used to compare in each severity of EMG. Our study group is matched one by one, so concluding that sensitivity is only 51% in moderate EMG group is misinterpreted.

As a retrospective study, not all of cases were recorded the duration from starting the hand elevation to provocation. Therefore, we could only get the result of whether it was positive or negative. We suspect that more specific results and analyses could be made if duration of provocation is also collected. Also, this study only investigated EMG severity as a factor that could affect hand elevation test. Authors think that some other patient factors may also affect on false negative hand elevation test, although it's beyond the scope of this study. Further study should identify other factors not mentioned in this study.

The hand elevation test is a proven simple, effective and reliable provocation test for carpal tunnel syndrome. However, there are some false-negative results, and mild severity of EMG can effect on the false results. Nonetheless, meaningful correlation was shown between EMG severity and hand elevation test, therefore supporting the value of hand elevation test.

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