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Comparison of Surface Electromyography (SEMG) Signal of Carpal Tunnel Syndrome (CTS) Sufferers and Non-Carpal Tunnel Syndrome (CTS) Sufferers

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Abstract: This paper investigates the group statistics for CTS sufferers and non-CTS sufferers. The entire effective bandwidth of the EMG signal may now be measured thanks to differential amplification. Because notch filtering causes the loss of significant EMG signal information, it is generally advised to avoid it. The features of the amplification mechanism play a role on the EMG signal's quality. Conclusion shows that the mean RMS SEMG value for people without CTS is higher than the mean RMS SEMG value for people with CTS. Table 1 shows that the mean RMS SEMG value for people without CTS is higher than the mean RMS SEMG value for people with CTS. Alternative Hypothesis (HA): Group 1's mean RMS SEMG value is greater than Group 2's mean RMS SEMG value. The mean of the SEMG signals used in this study were used to compare the workers in the manufacturing sector who had CTS and those who did not. The following is the assumption made in the analysis: The null hypothesis (H0) states that the mean RMS SEMG values for Groups 1 and 2 are equal. CTS is used as a grouping variable and SEMG value as a test variable in the analysis. The timing and force of the muscle contraction are just two examples of elements that affect the SEMG signal's amplitude, temporal, and frequency domain features.

Key words: (SEMG) Surface Electromyography, CTS (Carpal Tunnel Syndrome).

Introduction

Prior to the creation of muscle force, muscle fibres produce little electrical currents. As part of the signalling process for the muscle fibres to contract, ions are exchanged across the membranes of the muscle fibres to produce these currents. By placing conductive materials or electrodes on the skin's surface or invasively into the muscle, the electromyogram (EMG) signal can be monitored. Since surface EMG is non-invasive and may be performed by individuals other than medical professionals with little risk to the subject, it is the more popular type of measurement. The amplitude of the surface EMG signal and a number of other parameters affect surface EMG measurement. (SEMG) varies from the μV to the low mV range. The amplitude and time and frequency domain properties of the SEMG signal are dependent on factors such as:

The timing and intensity of muscle contraction.

- The distance of the electrode from the active muscle area.The properties of the overlying tissue (e.g. thickness of overlying skin and adipose tissue).
- The electrode and amplifier properties.
- The quality of contact between the electrode and the skin.

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Measuring and accurately representing the SEMG signal depends on the properties of the electrodes and their interaction with the skin, amplifier design and the conversion and subsequent storage of the EMG signal from analog to digital form (i.e. A/D conversion).

Types of SEMG Input Devices

There are three types of devices that connect to the MP45: electrodes, transducers, and I/O devices.

- Electrodes are relatively simple instruments that attach to the surface of the skin and pick up electrical signals in the body.
- Transducers, on the other hand, convert a physical signal into a proportional electrical signal.
- Input/output devices (I/O for short) are specialized devices like pushbutton switches and headphones.

Figure 1 EMG Experimentation Set-up

Literature survey

Rahayu K. et al. (2014) studied the effect of working posture and hand grip for carpal tunnel syndrome among aerospace workers. This method used the questionnaire on Psychology working experience and equipment using vibration force and hand grip strength. It determined the relationship between four factors; working experience, working posture, hand grip strength and exposure time. Ten male respondents aged between 18 to 58 years, who had been identified working with hand tool vibration (router gun, drill gun, flat sander, and angle grinder) were involved in the study. The hand grip test was conducted before and after the industrial workers do their job using the vibrating hand tool. The hand grip strength was found higher before using the vibration hand tool compared to after using the vibration hand tool. The percentage different of the grip was about 68.42%. The exposure time for the router gun was 5 hours per day where the router gun having the highest vibration points exceed 466 m/s². It was found that workers involving in this operation were having the maximum symptoms of CTS. The hang grip strength of the older workers was decreasing at a faster rate. Workers with more working experience were having more severe CTS symptoms. From the analysis of the CATIA Software, it was found that left arm was at less risk than right arm because it was supported by the panel.

Dale et al. (2013) studied the prevalence and incidence of carpal tunnel syndrome in US working populations by pooled analysis of six prospective studies. The majority of the workers were from manufacturing companies (64.0%) while others worked in construction, agriculture, healthcare, technical professions, and service work. In total, workers were recruited from > 50 employers or building trade unions across the six study groups. Data collection began in 2001 and ended in 2010. A common CTS case definition was created incorporating both symptoms and electro diagnostic studies (EDS) results from data that were collected in all

studies. Hand symptoms and were assessed using surveys or interviews at frequencies ranging from weekly to annually. All studies collected median nerve motor and sensory and ulnar nerve sensory conduction latencies across the wrist. All analyses were conducted using STATA (StataCorp, College Station, TX, USA). A total of 4321 subjects were enrolled across the six studies. The percentage of college graduates ranged from 0.7–20.6%, and the percentage of Caucasian study subjects ranged from 8.2–92.7%. Mean age at enrollment ranged from 30.8–43.4 years across studies. The prevalence of CTS was 7.8% among the members of this pooled cohort of 4321 mostly industrial workers with higher proportions among females and older age categories. Incident CTS was observed among 5.8% of 3515 workers, who contributed any person time to the analysis resulting in an incidence rate of 2.3 per 100 person-years.

Experimental works

A member of the thenar muscles, the abductor pollicis brevis (APB) is frequently impacted by the muscle atrophy brought on by carpal tunnel syndrome (CTS). There is still much to learn about the APB muscle's electrical characteristics. To spot alterations in a pathologically changed muscle, like in the case of CTS, it may be helpful to have accurate knowledge of the physiological fatigue behaviour of the APB muscle. However, it is crucial to use non-invasive diagnostic methods whenever possible in order to use this knowledge in a clinical situation. Fortunately, significant work has been achieved in recent years to create non-invasive methods for recording and processing surface electromyograms to assess the performance of a muscle (SEMG). The literature makes it clear that SEMG is a method for using electrical signals to measure how well the APB muscle is working. The mean of the SEMG signals used in this study were used to compare the workers in the manufacturing sector who had CTS and those who did not. The electromyogram signals' average root mean square values were calculated. The statistical significance is examined using the independent two sample t-test. Because there are two distinct samples of people to be compared, the independent sample t-test is utilised. People without CTS make up the first sample, whereas those with CTS make up the second. Between the two samples, there is no overlap. Depending on whether CTS is present, the entire workforce is split into two groups. Those who don't have CTS symptoms are assigned label „0" and those who have CTS symptoms are assigned label „1".

Group 1 („0" in the datasheet) has NO CTS.
Group 2 („1" in the datasheet) has CTS.
The hypothesis assumed in the analysis is as follows:

- Null Hypothesis H_0: Mean RMS SEMG value for Group1 = Mean RMS SEMG value for Group 2.
- Alternative Hypothesis H_A: Mean RMS SEMG value for Group1 ≠ Mean RMS SEMG value for Group 2.

In the analysis, CTS is grouping variable and SEMG value is test variable. The group statistics for CTS sufferers and non CTS sufferers is shown in the Table 1.

Table 1 Group statistics from SPSS

Group Statistics

	CTS	N	Mean	Std. Deviation	Std. Error Mean
sEMG	Non CTS Sufferers	66	.07005718	.151573803	.018657445
	CTS Sufferers	37	.03012817	.038046400	.006254790

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Results and Discussion

The SEMG signals of the APB muscle were analysed using an independent two-sample t-test, which reveals that non-CTS sufferers have superior SEMG signals than CTS sufferers and are more susceptible to probable CTS symptoms.

Conclusion

Table 1 shows that the mean RMS SEMG value for people without CTS is higher than the mean RMS SEMG value for people with CTS.

Future Scope

In comparison to a manual goniometer, an instrument known as an electrogoniometer is capable of detecting wrist angle with more accuracy.

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