Study of musculoskeletal disorders using electromyography and electrogoniometer

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Summary

Making accerate measurement for joints, velocity and the possibility of repeating in the same conditions are important factors in the study of the origin of musculoskeletal syndromes. Electrogoniometry enables relatively simple and objective assessment of posture and moment of joints.

In this work it was measured and demonstrated the accuracy and feasibility of using an electrogomiometer in assessing carpo-falange joint, carpial tunnel syndrome, very common pathology nowdays. To obtain feasible results we used in the same time with electrogoniometry of carpo-phalange joint and adductor muscle electromyography and thumb flexor depending on carpo-phalange joint requested while typing a text on the mobile phone or a personal computer.

Introduction

The function of the hand is central to all human activities and played a crucial role in human evolution. Hand has important functions in communication, body language and touch.

Despite of all the recent mecanization of production activities in industry, proper functioning of such equipment is not possible without human hand work.

Especially thumb is important for the proper functioning of the hand and its role is central in carrying out everyday simple tasks. With thumb we can't use computers remote controls, game controllers and the mobile phones which became an inttegral part of modern life.

Key words: electrogoniometry, electromyography, carpal tunnel neurophathy, muscle weakness.

Material and methods

This paper aims to highlight the existence of musculoskeletal disorders with their location and their main professional reasons.

The position, frequency, speed, acceleration and hands during daily movements are considered to be important factors that may play a role in the development of musculaskeletal disorders.

Same of thumb disorders received a name, such as "Nintendomites" and "Thumb Blackberry" to assign the device disorder which was considered to aggravate the pathalaghy. In the last decade has been an alarming increase in the use of mobile phones and other small portables devices for enjoyment and communication (eg: Pods, web-phones, etc.), text messaging and games.

In Romania, the number of text messages increased to 70% and the use of these devices will probably continue to rise, particularly among teengers. The intensive use of mobile phones and other devices for information and communication technology (ICT) could expose fingers operating voltages beyond their intented functions, which can cause pain and musculaskeletal disorders associated the thumbs and joint.

Objective physical measurements associated with the use of portable devices can provide a basis for recommendations on how to reduce the physical burden and perhaps to increase efficiency during operation.

Electrogoniometry

In this study we chose electrogoniometry as a measurement method because the mobility and posture of the joints can be captured continuously, repetitively and we can make a further characterization of the subject joint and interpretate the captured data. It's part of kinesiometry to asses the potential of the subject: reliable, reproductive, easely identifiable anatomical landmarks, appreciates the active mobility and joint potential liabrilities (amplitude of assets).

Willing in uniaxial shaped, the electrogoniometer used in our study contains a potentiometer, it is a beud seusor. Placed along the angle to be measured, the potentiometer produce a variable output voltage that depends on the degree of mobility. The advantages of electrogoniometry include easy configuration and data processing, relatively low cost, portability collection work.

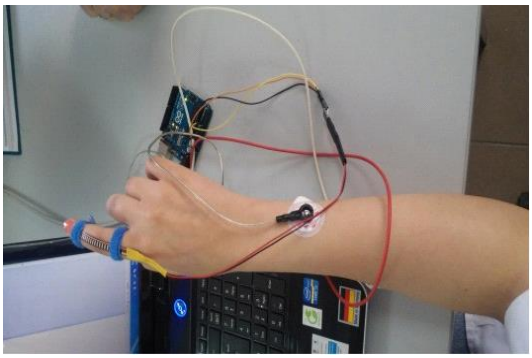

Fig.1 The ensemble with the elecetrogoniometer used in ower studies

The system used in our study, contains a uniaxial goniometer connected to the ARDUINO system which is basses on a microprocessor AT Mega 328. Data collected using both electrogoniometry and the electromyography were tracked and recorded in real time using two computers by installing conducted as described in the picture below.

Electromyography

In this study we choose to record muscle activity also involved beside recording joint activities using electromyography (EMG). Muscle activities was recorded using electromyography (EMG) and it was used to characterize the muscular system involved in terms of charging. Although there is a clear conection between the carpo-phalange joint and adductor muscle and thumb flexor two method of monitoring and diagnosis did not match up to this moment .

The surface of EMG recording were elected two distinct muscles that facilitated their location. These muscles are also known to be involved in the gripping task. From the thumb muscles the deeper muscle that could maybe get better results for measuring exposures to the thumb, but this method is invasive and requites electromiography and qualifical technician and a correct placement of the electrodes can be a challenge.

To achieve electromyography we used a system from BIOPAC MP150 purchase. To signal collection were used disposable electrodes, connected in bipolar system. Data were recorded in real time and there were analyzed.

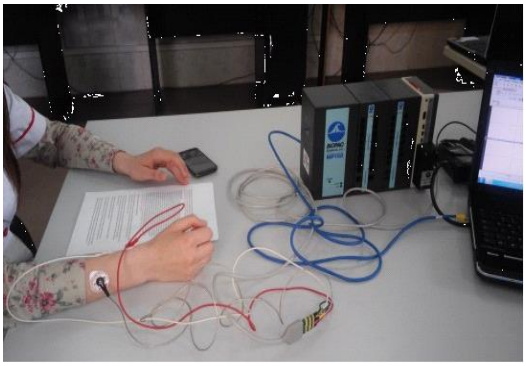

Fig.2 The ensemble used in capturing the electromyography

Adduction/abduction, flexion/extension thumb was measured using a system of electrogoniometry.

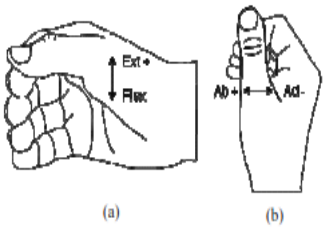

Fig. 3 The angles of adduction / abduction, flexion / extension of the thumb

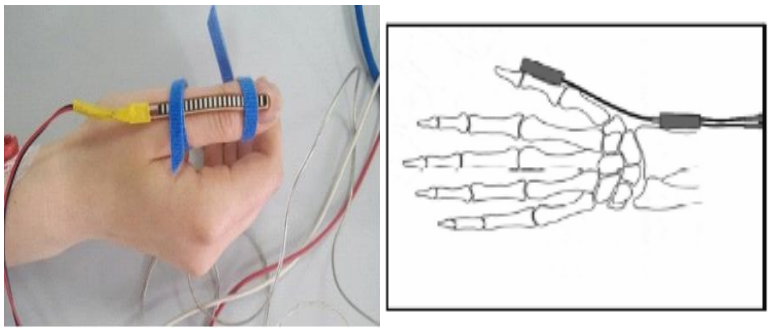

Fig.4 The ensemble used in capturing the electrogoniometry

Working protocol

We used young subject aged between 21 and 23 years old, category exposed to carpel tunnel syndrom, the large number of hours spent at the computers and through daily communication using SMS. The recordings were made on 10 subject in order to verify the method, but in the future studies, the number of subjects will be increased in order to improve the recording method. The subjects were seated inconfortable position, sitting on a desk.

To asses musculaskeletal disorders, we used two types of evidence on each subject:

- Alphanumeric text typing using a smartphone and its keypad
- Typing the same text a computer laptop

When the subject typed the alphanumeric text using a smartphone, we positioned the goniometer on the thumb and electrodes for miography on the adductor

muscle of the thumb as shown in figure 6. We have made necessary records for each subject.

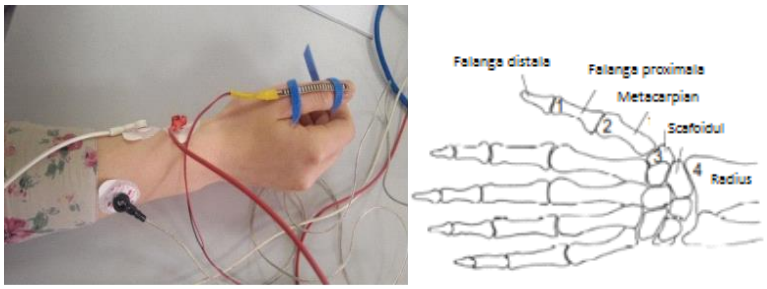

Fig.6 Goniometer position on the thumb and electrodes on the adductor muscle of thumb for the miography

When the subject typed alphanumeric text on personal computer, the goniometer was positioned on the index finger of the thumb as shown in figure 7, and were made necessary records for each subject.

Fig.7 Goniometer position on the thumb and electrodes for miography on the flexor muscle of thumb

Results and discussions

For each position of the finger, measuring errors were calculated as the difference between the position of the finger using a manual goniometer and recorded elctrogoniometer angle.

The study identified common ranges of motion used when using mobile phones. When subject used their own phone, the maximum flexion was 98.1 ^{0} which accounted for 55% of maximum voluntary flexion and maximum extension.

Recording thumb Ad/Ab, maximum obduction was 6.3^{0} and maximum adduction was 26.2^{0}, which accounted 79% of the volunteer.

This demonstrates that the use of all phones for typing, extension and flexion of the thumb sustained, leads to pssible risk factors that may contribuite to postreal disorders of the thumb. Beside, the writhing speed can also be a risk factors that may lead to musculaskeletal injuri.

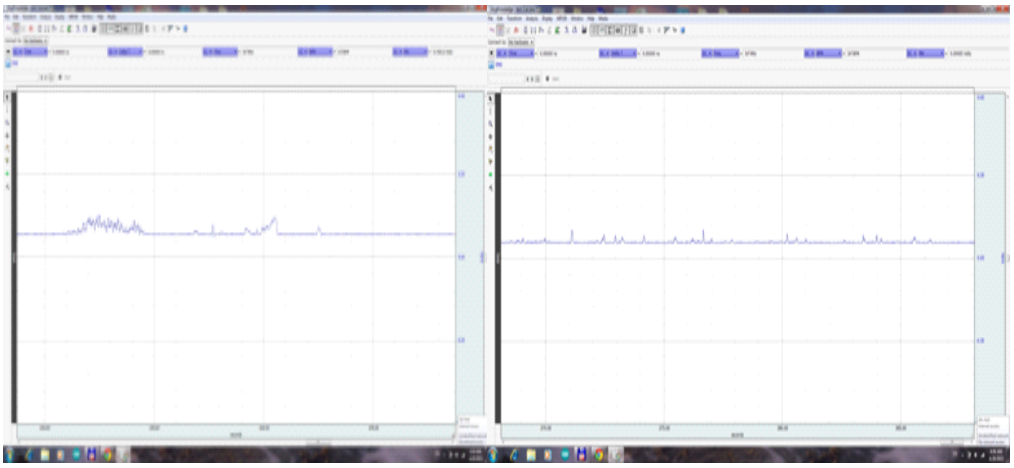

Fig.10 Integration of the electromyographic signal obtained
a) typing text telephone **b**) typing text on the personal computer
(**a**)Note: the muscle fatigue is reduced (10 min recording) (**b**) Note: tired muscles involved is obviously higher, after just 10 minutes of recording.)

If the values obtained after performing electrogoniometery thumb are correlated with integrated electromyographic signal, indicates that muscle fatigue, and request carpo-phalange of the thumb joint is reduced when typing a text with a mobile phone, because the subject can change hand position so he has a comfortable position and not require joints involved. The possibility of the Carpian syndrome can not put the problem in this case because there is no compresion above the median nerve.

If we analyze the integrated electromyographic signal obtained after typing a text using a personal cpmuter, we observe a very intense and continuous activity of the muscle involved. Angular values of carpo-phalange of the index obtained, indicates a heavy use of the hinge. In addition, the subject doesn't have a comfortable position of the hands and interfering also the fatigue of the muscles.

Group correlations have been made and have been found combinations of exposure parameters for the entire duration of the task of typing, using the smartphone and the notebook, comparing the differences.

In addition, correlations were observed in some of the cross-correlations calculated between the two signals. This leads to the conclusion that correlations between EMG and goniometer can have a smaller temporal association and can be used directly to each other on the purpose to identified associations.

Because the goniometry measures an external exposure - the angle, the EMG measures the internal exposure - the force, goniometry and electromiogrphy offers different aspects of exposure and they are not interchangeable.

One limitation it was that measurement errors associated with the dynamic movements of the wrist have not been characterized. A second limitation is the limited precision associated with our methods used to position the electrodes and the electrogoniometry sensor , by any prejudice that may be associated with the use of our equipment.

In our future studies we want to achieve the electrogoniometry of all the structures, and to show the involvement of all finger joints because when you write using the keyboard of the computer, it's not used just the index. We will include as well the wrist to show the carpian tunnel syndrome in our next study.

Conclusions

The conclusions that we can draw from using the electromiographys is that fatigue that occurs after spending a long time using the keyboard of the computer may produce some occurrence like:

- muscle fatigue (static and dynamic) - due to muscular effort and contraction of the non flexible muscles;
- neuro-sensorial fatigue - caused by the high nervous tension of the senses (eyes, ears);
- psychic fatigue - caused by psychic facts.

Following values obtained from electrogoniometry shows that the small joints of the index finger are more requested against the thumb.

In conclusion typing an alphanumeric text on the Smartphone device can not lead to the carpial tunnel syndrome. Muscle fatigue occurs mostly after typing an alphanumeric text using the keyboard on the personal computer, both because of muscular effort and having an incorrect hand position who requires joints around, including a large number of muscles.

The results obtained in this study, is a preamble in terms of understanding the importance of measurements about the joint fingers and it's gonna serve as a basis for further research study.

This work may help to design new studies or interpret existing studies about the common position of the thumb and index. Electrogoniometry systems available today are quite easy to use and provides relevant data. But electrogoniometry it's having limitations and it is very important that those who prepare and make the mesures with the electrogoniometer, understands these limitations. For example, calibration and normalization procedure of the electrogoniometer is crucial and it will affect measurement accuracy.

Some physical changes to methodologies and today electrogoniometry can improve measurement accuracy. The electromyography, the miography offers

different aspects of exposure and they are not interchangeable in general.

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