Development of Patellar Reflex Measurement using Linear Variable Differential Transformer

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Abstract

This project presents the development of patellar reflex measurement system using Linear Variable Differential Transformer (LVDT). The measurement system is based on knee reflection as the patellar tendon was tapped with tendon hammer. The system proposed capable to detect four graded levels of Deep Tendon Reflex (DTR) which are zero absent, hypoactive (underactive), normal, and hyperactive (overactive). The LVDT sensor use to convert the mechanical displacement of leg reflection into voltage signal. The signal will go through Data Acquisition Card (DAQ) and displayed by personal computer (PC). LabVIEW 8.0 software will analyze the voltage signal and the patellar reflex will be graded based on the peak voltage signal. The data can be saved in Microsoft Excel file (.xls) for record and references. The measurement system has been test on 20 respondents for validation purpose. The development system is user friendly and able to assist neurologist to analyze and graded level of the patellar reflex measurement.*

1. Introduction

The knee-jerk reflex or deep tendon reflex is also medically called the patellar reflex. In neurologist areas, deep tendon reflexes [1] are the important physical sign for neurological diagnosis since every patient can has their normal and abnormal reflex response depend on underlying pathology. Deep tendon reflex (DTR) can be graded into the following levels; zero absent, hypoactive (underactive), normal, hyperactive (overactive) without clonus (extra jerks), hyperactive with unsustained clonus (just 1 or 2 extra jerks), and hyperactive with sustained clonus (continued jerking).

The reflex level can be detected after the patellar tendon is tap. It is important to understand that the deep tendon reflex alone cannot give definite diagnosis of certain neurological [2] disease. With the advancement of this area, it is vital to have a system that capable to manage all the medical data electronically. Basically, the ideas of this project is to come out with a system that capable to observe, capture, analyze patient reflex level and display the result on a personal computer.

2. Methodology

The proposed system will present a new tool for measuring the patellar reflex, specifically by using the LVDT sensor and utilization of the GUI in LabVIEW 8.0. This system will help to demolish the contradiction among medical practitioner about the reflection and the graded level of the patellar reflex measurement. The block diagram of propose system shows in Figure 1.

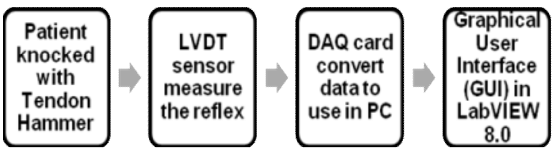

Figure 1. System block diagram

2.1. Measuring technique

In this project, the standard tendon hammer was used to knock the correspondent patellar tendon and

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the tapping force are assume same. The 50 Newton of force tap is the suitable tapping force according to S.J. Schultz et al. [3]. The LVDT sensor will measure the knee extension distance after the tendon hammer knock the patellar tendon. The knee extension gives the LVDT displacement transducer output in voltage signal. The output voltage is scale from 0-11 scale represent the displacement of leg reflection. The maximum range of reflex would be round to the nearest integer. The integer consists of four case structure selections. This selection corresponding to four reflex levels graded which are zero absent, hypoactive (underactive), normal, and hyperactive (overactive). LabVIEW software will be programmed to detect the peak voltage of the sensor and group it into reflected graded level. Figure 2 shows the flowchart of the reflex level graded programming code.

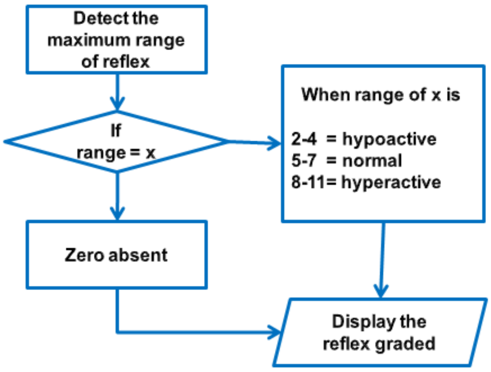

Figure 2. Flow chart of the reflex level graded programming code.

2.2. System verification

All the experiments were performed at Medical Electronics Laboratory, Department of Electronic Engineering, Faculty of Electrical and Electronic Engineering, University Tun Hussein Onn Malaysia (UTHM). There are ten males and ten females ages in between 22 to 24 years old selected to be respondent. They are reported with no previous history of knee ligament injury or surgery, no history of connective tissue disorders or diseases, and no lower extremity injury in the past six months [3].

2.3. Patellar reflex testing apparatus

The normal knee-jerk reflex may range between hypoactive and hyperactive [4]. A custom reflex testing apparatus has been designed to measure the patellar tendon reflex. The model was design with adjustable holder to position and hold the LVDT sensor for best measurement result. Figure 3 shows the model of reflex testing apparatus attach to the modified shin pad. The shin pad was modified in order to hold the sensor and prevent from slip during the knee jerk response.

Figure 3. LVDT attached to the modified shin pad.

2.4. Data Analyses

The data from the measurement of LVDT sensor will be analyze using LabVIEW 8.0 software. The data can be saved in Microsoft Excel file extension (*.xls) based on the respondent names. The pattern of the patellar reflex measurement is plotted based on this data as shown by Figure 4.

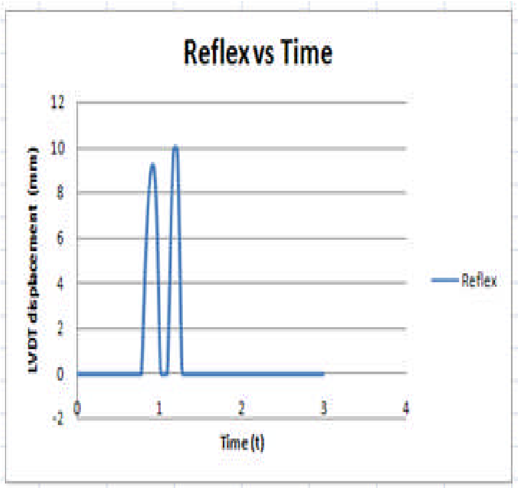

Figure 4. Plotted of reflex data in Microsoft Excel.

3. Result and discussion

Figure 5 shows the front panel of the Graphical User Interface (GUI) in LabVIEW to measure and display the reflex level of patellar reflex measurement. The

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reflex pattern is plotted based on the output voltage from the LVDT sensor. The peak voltage from the sensor output will be used to determine the graded of the reflex level. The reflex graded automatically measure and display on the GUI panel. The detection of reflex graded is based on the programming code as shown on Figure 2 flowchart.

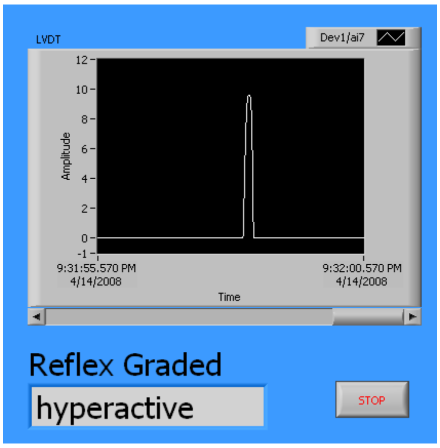

Figure 5. Reflex graded level detected in system front panel.

The performance of this system has been verified by measure the patellar reflex measurement of 20 respondents. Table 1 shows the results of the experiment.

Table 1. Experimental result of 20 respondents.

Reflex Level	Respondents
Zero absent	2
Hypoactive (underactive)	8
Normal	6
Hyperactive (overactive)	4

Based on Table 1, most of the respondents detect to have hypoactive reflex level followed by normal reflex level, hyperactive level and zero absent level. From the experiment, we have notice that, the reflex sometimes cannot appear easily due to the respondent behavior. As a consequence, if the respondents feel uncomfortable with the test, the measurement process will face a difficulty. Therefore, all the respondents were asked to squeeze a racquetball or any small object while the measurement was taken. The ball squeeze was used to distract the subject's attention and facilitate the elicitation of the deep tendon reflex.

The reflex graded analysis also affected by low vibration of the tapping force on the tendon. The low vibration occurs at range of 1 to 2 mm which affected the graded level of measurement. Therefore, the low vibration of the displacement must be considered while doing the analysis.

4. Conclusion

The development system which presents a new tool for patellar reflex measurement utilized LVDT sensor and LabVIEW software. The LVDT sensor is very suitable to measure the reflection of knee jerk occurs as the patellar tendon was tapped with tendon hammer. The Graphical User Interface (GUI) is develop to measure the reflex level and stored the reflection data for further analysis. The measurement system has been test on 20 respondents for validation purpose. The development system is user friendly and able to assist neurologist to analyze and graded level of the patellar reflex measurement.

5. References

[1] J.P.R, Dick, "The deep tendon and abdominal reflexes", J. Neurol. Neurosurg. Psychiatry, 74, 2003, pp.150-153.

[2] Monrad-Krohn, G.H., Refsum S, *The clinical Examination of the Nervous System*, H.K Lewis & Co, ed. 12, London, 1964.

[3] S.J. Shultz, C.R. Carcia, D.H. Perrin, "Knee joint laxity affects muscle activation patterns in the healthy knee", J. Electromyogr.Kinesiol. 14, 2004, pp. 475–483.

[4] Dejong, R.N., *The Neurologic Examination*, Paul B. Hoeber Inc, .ed. 4. New York, 1958.