MUSCLE ACTIVITY AND GAIT ANALYSIS OF ASSISTIVE DEVICE FOR GAIT ABNORMALITIES PATIENT

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Submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Hons)

by

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DECLARATION

I hereby, declared this report entitled "Muscle Activity and Gait Analysis of the Assistive Device for Gait Abnormalities Patient" is the results of my own research except as cited in reference.

Signature : ....

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Date : 21 January 2021

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for the degree of Bachelor of Manufacturing Engineering with Honours. The members of the supervisory committee are as follow

…………………………………

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ABSTRAK

Gait abnormalities merupakan satu penyakit yang mengakibatkan pesakitnya tidak boleh berjalan dengan lancar. Penyakit ini berpunca daripada beberapa faktor antaranya, genetik, kemalangan, masalah kesihatan, dan beberapa faktor lain lagi. Sesetengah penyakit ini boleh dirawat namun terdapat juga sesetengah kes yang tidak dapat dipulihkan dan hanya boleh dibantu dengan cara pemulihan atau fisioterapi. Penyakit ini boleh mengganggu aktiviti seharian pesakit kerana ketidakselesaan pada bahagian kaki pesakit untuk berjalan secara normal. Satu alat untuk menyokong meringankan beban pesakit telah dihasilkan, namun kajian keatas keberkesanan dan sejauh mana alat tersebut dapat membantu meringankan masalah ini belum dikenal pasti. Oleh itu, satu alat yang dikenali sebagai Electromyography (EMG) digunapakai dalam mendapatkan maklumat tersebut. Selain itu, kajian ini adalah untuk melihat perbezaan antara keadaan saraf manusia normal dan saraf pesakit. Di samping itu, kajian ini bertujuan untuk melihat keberkesanan alat sokongan ini dalam mengurangkan regangan saraf yang dihadapi pesakit dalam pada masa yang sama mampu maningkatkan masa untuk saraf menjadi letih, (time-to-fatigue). Akhir sekali, kajian ini bertujuan untuk menganalisa perbezaan keadaan saraf pesakit tersebut dengan memakai dan tanpa memakai alat bantuan. Berdasarkan kepada kajian ini, keputusan dan analisa yang Berjaya diperolehi ialah berlakunya kadar pengurangan dalam peratusan nila purata RMS (%) terhadap regangan saraf pesakit dalam masa yang sama mampu meningkatkan masa yang diambil untuk saraf pesakit menjadi lemah. Kajian ini telah berhasil mengurangkan keletihan pada saraf seterusnya membantu para pesakit dalam melakukan kehidupan seharian dengan lebih mudah.

ABSTRACT

Gait abnormality (GA) is a muscle disorder that disabling the patient to walk properly. This is caused by several factors including genetic influence, accident history, health issue, and others. Some who suffered from this illness can be cured but there are some other cases which the patients are not be able to be fully cured and only can be helped by physiotherapy. The disability to walk properly caused by this muscle disorder can affect the patient's daily activities as they feel the difficulty to walk properly as a normal person could. An assistive device to help the patient to walk has been developed however the effectiveness on the device's performance to serve its purpose has not yet been confirmed. Therefore, an electrical tool known as the Electromyography (EMG) is being used to obtain the information required. Besides, this research is to analyse the comparison of the patient's nervous system with the assistant device and without the device. In addition, the main purposes of this research is to study the effectiveness of the assistive device in reducing the muscle contraction faced by the patients at the same time to increase the time-to-fatigue of the muscle. Thus, the findings of this research show that the reduction in percent of average RMS (root mean square) value to the patient's contraction muscle when using the device which in return has increase the time-to-fatigue of the muscle. Last but not least, this research has achieved the objective which is to minimize the muscle fatigues in order to ease the patient in their daily chores.

DEDICATION

Only

My beloved father, Komaruddin bin Hussain

My appreciated mother, Maznah binti Mohammad

My adored siblings, Liana, Marzuki, Aisyah, Rahmah, Amirah, Ilham

My supportive supervisor, Mdm Ruzy Haryati, my friends, UTeMs' staff and everyone who directly or indirectly involved in this research for giving me moral support, money, cooperation, encouragement and also understanding.

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LIST OF ABBREVIATIONS

GA	-	Gait Abnormalities
ABS	-	Acrylonitrile Butadiene Styrene
AFO	-	Ankle and Foot Orthosis
AM	-	Additive Manufacturing
CAD	-	Computer Aided Dseign
CAM	-	Computer Aided Manufacturing
CNC	-	Computer Numerical Control
GLH	-	Gastrocnemius Lateral Head
EMG	-	Electromyography
FO	-	Foot Orthosis
ID	-	Identification Data
KAFO	-	Knee, Ankle and Foot Orthosis
PA	-	Polyamide
PE	-	Polyethylene
NP	-	Normal Patient
PRC	-	Perkeso Rehabilitation Centre
PP	-	Polypropylene
PU	-	Polyurethane
PL	-	Peroneus Longus
PLA	-	Polylactic Acid
RF	-	Rectus Femoris
RMS	-	Root Mean Square
sEMG	-	Surface Electromyography
TA	-	Tibialis Anterior
TPE	-	Thermoplastic Elastomer
TPU	-	Thermoplastic Polyurethane

CHAPTER 1

INTRODUCTION

This chapter gives a brief introduction of project's background based on the general information regarding the gait abnormalities and the objectives of this project. The problem statement, objective and scopes will also be explained in this chapter. Project planning and execution of this project, significant and organization of this project also include in this project.

1.1 Background of Study

Gait is defined as a person's manner of walking, meanwhile abnormalities refer to irregularity of feature or occurrence. Gait abnormalities (GA) is when a person unable to walk in a normal pattern. They faced this complication due to several reasons such as underlying conditions, genetics, injuries, stroke, or problems with the legs and feet. However, intervention as an assistive device produced in order to help in improving the gait abnormalities and capabilities of the post-stroke people as in recovery process. Physical therapy able to help improving a person's gait and reduce their uncomfortable symptoms. One of the physical therapy is by using tool or leg support. Currently, the Gait Abnormality Assistive Device (GUARD) is one of the tool examples, which used to reduce the GA issue, but how far this support device could affect the muscle activity to reduce this issue.

Thus, the functionality of surface electromyography (sEMG) is used to detect muscle function or muscles activity through electrical stimulation. Consequently, the analysis of muscle of people or patient through sEMG was proposed to detect the functionality of an application of current device. The result of this work resulted in confirming the usage of GUARD in reducing the muscle activities and improve fatigue level of the users. This project contributes to society in improving their capabilities and quality of life.

1.1.1 Assistive device

Paramyotonia Congenital (PC) is one of the health problem that contributes to the GA. PC is a significant worldwide medical issue whereby numerous survivors have neglected necessities concerning versatility during recuperation. Thusly, the utilization of automated helped device (i.e., a bionic leg) inside a network setting might be a significant extra to typical physiotherapy in ceaseless stroke survivors (Wright et al., 2018). In order to help the patient with GA, an assistive device has been produced recently. Nevertheless, the functionality of the device has been approved since it is able to be used well on the patient. Somehow, the effectiveness of the device still cannot be determined as there is no statistically evidence or data that the device may help the GA patient. The device is expected to be able to reduce the muscle contraction of the patient during walking and climbing thus can increase the time-to-fatigue of the muscle.

The assistive device mechanisms work basically by distributing to leg load to the hand of the patient in order to reduce the load. Meaning that the load is being shared with the hand. This is because GA patient facing the complications at the leg part, the leg muscle tends to having contractions more than the normal people. So, that is the reason why the muscle of the patient takes shorter time-to-fatigue. This condition will cause difficulties to the patient from doing their daily activities.

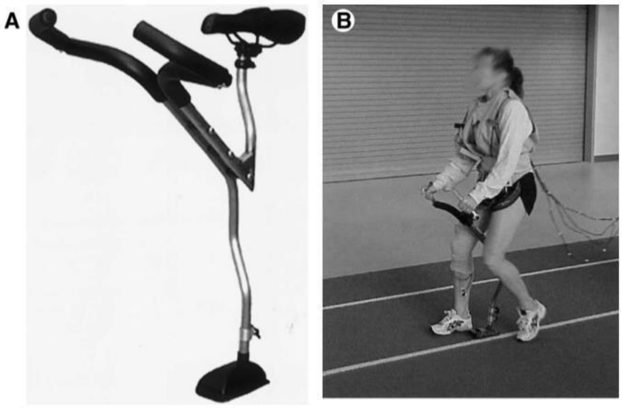

Figure 1.1 assistive device (Wright et al., 2018)

Figure 1.1 above shows an example of assistive device in the year of 2018. The device is being fabricated to help patients with stroke as a post treatment. The device can be found in some rehabilitation centre. For this research, new other device is being used in order to study how the device works for the GA patient. The effectiveness of the device to the patient will be measured throughout this research. Figure 1.2 below shows the device selected.

Figure 1.2 assistive device for GA patient (2019)

1.2 Problem Statement

Hodo (2017) state in his previous study regarding abnormalities of lower leg muscle, varieties in lower leg life structures have been all around archived throughout the years with high-goals imaging modalities, for example, MRI and ultrasonography encouraging recognizable proof of a greater amount of these anomalies. Albeit frequently coincidental discoveries, the distinguishing proof of these variations from the norm can, in specific cases, be clinically critical on the grounds that they can be a wellspring of constant agony, gait irregularities, and injury. Nonetheless, a few variations can be valuable in careful recreation (Hodo et al., 2017). Currently, the Gait Abnormality Assistive Device (GUARD) has been produced in order to reduce the GA issue. Unfortunately, this device has not yet been analysed for its performance on muscle. This device is created to reduce the muscle stretch on leg at the same time increase the comfortability of the patient to walk in a normal condition. This project will begin with the investigating on the muscle activities between the normal people and GA patient then it will continue with analysing the data of the muscle. A specific tool called as Electromyography (EMG) will be utilized in order to get the data.

1.3 Objective

1. To investigate muscle activity and gait analysis of normal people and GA people.
2. To analyse the muscle activity and gait analysis of the assistive device GUARD for GA people.
3. To evaluate the effectiveness of using GUARD to muscle and time-to-fatigue of GA people.

1.4 Scope

This project will focus on investigating muscle activity between normal people in Sekolah Menengah Bukit Baru and patient with Gait Abnormalities in Sekolah Menengah Bukit Baru. It is as well as investigating GA of normal people and GA of PERKESO Rehabilitation Centre patient, both case study located in Melaka. The results of muscle activity towards the Gait Abnormality Assistive Device (GUARD) on the patient are going to be concluded in this project. The device suggested could reduce the amount of muscle contractions in order to increase the gait comfortabilities. This study is being conducted on 3 normal people in average age of 15-24 years old. For the GA patient, since the fabricated product is based on 1 real case study thus the sample number for patient with that rare abnormalities is 1. The patient is 15 years old. The scopes of this project are:

i. Interview are conducted to normal people and GA patient at PRC and SM Bukit Baru.
ii. Perform Muscle test using EMG in order to study the difference of muscle behaviour between normal and GA patient.
iii. Analyse the result obtained from the interview and EMG.

1.5 Organization of The Report

The significant of this study is to assist to the Gait abnormalities patient in order to overcome the gait disorders. Patient with this abnormality are facing complications to deal with their daily activities. The previous study shows that GA patient tend to lose their strength and ability to walk normally when their muscle begins to tired due to continuous stretch and load at their leg muscle. During this situation, patient unable to proceed with their daily activities. This study is expected to able to solve this problem by enable to reduce their uncomfortableness thus reducing their muscle stress. This will be proven by analysing the muscle behaviour of the patient with the Gait Abnormality Assistive Device (GUARD) by using the EMG.

1.6 Project Planning and Execution

In this project, Gantt chart is constructed to list all the related task and reallocate time to finish the respective task from the beginning until the end of the project including dated of report submission. This project schedule is presented in Appendix A.

1.7 Thesis Organization

This final year project is comprised of further four chapters as follows

- Chapter II. Literature Review: This chapter gives a general classification of Gait Abnormalities (GA), physical effects, and hemiparesis condition in GA, hemiparesis disabilities in term of range of motion and which muscles involve on the affected upper limb part, technique recovery for hemiparesis patient. Apart from that also includes method to evaluate the muscle strength which is manual muscle testing and also the information regarding existing intervention of arm slings and the important of assistive device for patient with hemiparesis condition.
- Chapter III. Experimental procedure: describe the experimental work or procedure involved during product development. This chapter consist of method of data collection, material used, mechanism of the product, experimental analysis, types of software used to analyse the data which is EMG software
- Chapter IV. The process of collecting data more detailed. The result of survey analysis. The discussion in every graph obtained from raw data. The comparison of muscle behaviour between normal and GA patient.
- Chapter V. The sections that will comprise the overall findings and discussion of the project and the recommendation for future works is outlined in this study are presented

1.8 Summary

In this chapter, the general knowledge of gait abnormalities is explained. There are several types of causes can lead to this problem. GA people are having trouble since they cannot be independent to perform daily routine. This project is to study further about the muscle activity of GA people and normal people, the problem statement also briefly explained in this chapter for understanding the purpose of this project. Then, an objective and scope of this study also stated in order to solve the problem statement.

CHAPTER 2

LITERATURE REVIEW

This chapter shows a brief overview from the past researches and studies conducted. All the information obtained is cited to the owner of the study. The previous research is for a guideline to the new project

2.1 Introduction to Gait Abnormalities

In general, GA in patients can be recognized by straightforward strolling tests, in any case, in research centre creatures this is progressively convoluted and a few tests have been created, for example the open field test and impression examination. Here are eight basic pathological gaits that can be endorsed to neurological circumstances: spastic diplegic, hemiplegic, myophatic, neuropathic, choreiform, ataxic (cerebellar), sensory Parkinsonian, and a choreiform. Diagnosis of these gaits are crucial and important aspect of observation as it could provide information regarding neurological and musculoskeletal conditions for GA patients.