DOI: http://10.5281/zenodo.4415112

Experimental Measurement and Analysis of Knee Flexion Angle as a Biomechanical Parameter for Obesity

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***Abstract*— Walking or gait is the systematic study of human locomotion using visual observation, video cameras, sensors or combination of these technologies. Abnormalities of the gait can be observed in obese, Parkinson's disease and those having biomechanical disorders. Obesity may be considered as a complicated disease and situation which leads to major health problems. During walking, the joints of lower extremities are subjected to enormous forces and moments. Experimentally the walking of normal and obese subjects was video recorded by Microsoft Kinect camera. Simultaneously, the EMG (electromyography) signals were measured by Delsys Trigono EMG instrument through its electrodes placed over gastrocnemius muscles of the leg. Both the measured data was stored in the computer and analyzed. It has observed that the knee flexion angle is smaller by 30 % than the normal subjects of the same age group. Therefore, the knee flexion angle could be used as a biomechanical parameter to distinguish between normal and obese people which could help them to control the obesity, otherwise more serious health complications are possible.**

***Keywords*— Obesity, gait analysis, gastrocnemius muscle, EMG, Microsoft Kinect camera**

I. INTRODUCTION

Obesity is complicated disease and situation which leads to major health problems [1]. It is also called overweight and by definition of World Health Organization (WHO) it is abnormal or excessive fat accumulation that presents risk of health [2]. As statistics by WHO called global health observatory data, Saudi Arabia are one of the countries that have obesity prevalence more than 60% [3].

The most widely used method to determine obesity or a health weight is body mass index (BMI) [4]. The BMI can be calculated by dividing the weight with the square of height of a person. A person with a BMI of 30 or more is generally considered obese.

There are many techniques to measure the obesity such as waist circumference, waist-to-hip ratio, skinfold thicknesses, and bioelectrical impedance [5] Magnetic resonance imaging, dual energy X-ray absorptiometry methods are also used for diagnosis of obesity during research studies. Probable risk factors for obesity and overweight has been reported by the researcher using machine learning algorithms [6-8].

Overweight and obesity could be down to foot problems. Increased pressure on tendons and muscles of the foot tend to occur overpronation in obese people [9]. Such a biomechanical burden could lead to degenerative joint diseases in lower extremities and eventually, walking impairment. Therefore, observation of walking pattern among obese people is very important in regard to preventive care. In this paper, we report the results of our experimental study on impact of walking on obese people.

II. METHODOLOGY

Bipedal walking activity in humans is a complex skill that takes years to develop through maturity. Everyone needs to walk and move around during their daily activities. In the process of walking or gait, the motor system including the foot and leg movements are involved. Abnormality in gait might be due to physical condition, musculoskeletal injuries or diseases like PD [10; 11] or stroke [12]. Obesity and overweight could also affect the functionalities of gait. In this research, we propose to conduct an experiment for gait analysis in normal and obese men. Figure 1 shows experimental set up to record the dynamic gait parameters and EMG signal. Microsoft Kinect camera detects the prominent joints of lower extremities and surface electrodes of EMG (Trigno Wireless System, Delsys Inc., USA) are firmly fixed on the right leg muscle. The subjects under test will be asked to walk normally on the floor and it will be video recorded.

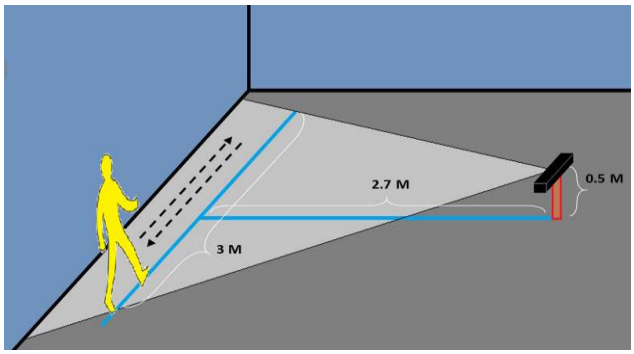

Figure 1: Kinect camera position with subject walking line.

Five male healthy subjects (Height 167.4 ± 0.8 cm ; weight 60.1 ± 8.82 kg ; Age 24.8 ± 3.82 years; mean ±SD) and one male obese subject (Height 173 cm; weigh 92 kg; Age 41 years) participated in this study.

All participants have no musculoskeletal problems or injuries or any musculoskeletal diseases. Participants were asked to walk normally barefoot in complete gait cycle as in figure (2).

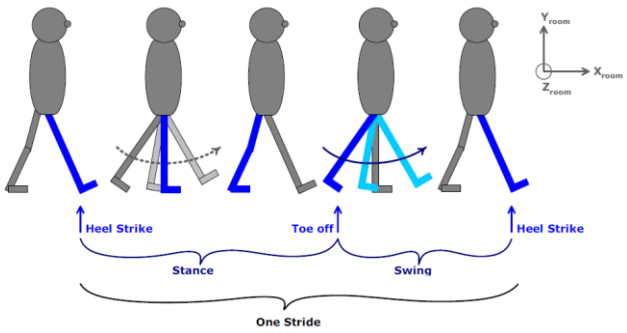

Figure 2: complete gait cycle.

Experimental Setup

Participants were asked to walk a complete normal gait cycle while recording their motion using a Microsoft Kinect camera V1 along with Delsys EMG sensor on the right leg attached to gastrocnemius lateral head as in Figure 3.

Figure3: GASTROCNEMIUS lateral head.

Microsoft Kinect camera programmed to record real-time skeleton view for the participants while walking as in figure 4.

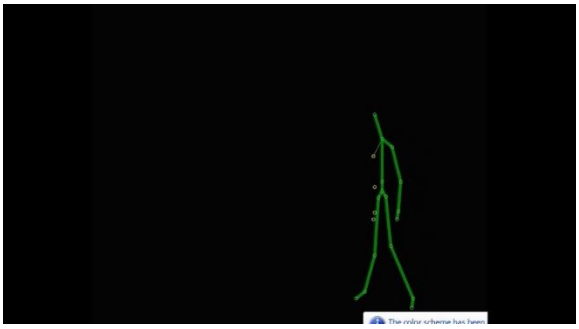

Figure 4: Microsoft Kinect Skeleton View Recording.

The data was gathered by two instruments, for EMG signal we used Delsys Trigno Wireless EMG system and for recording the gait analysis we used a Kinect camera v1 which has a software that convert the real time image into skeleton image for image processing for measuring knee flexion angle.

Participants started with walking their barefoot normal walk with their right leg first and stopped after completing gait cycle.

III. RESULTS

Figure 5 shows the different EMG signal between normal subjects and obese subjects which is shown below.

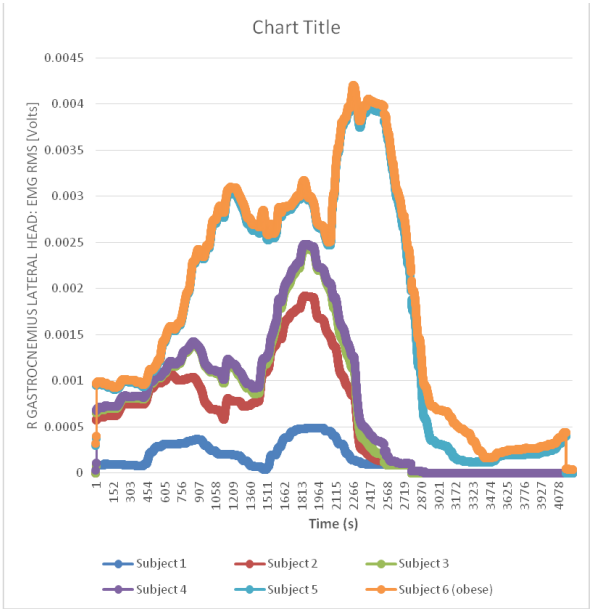

Figure 5: EMG signal of normal and obese subjects

Comparison of knee flexion angle at mid-swing phase among the normal and obese subjects is shown in the bar graph (Figure 6).

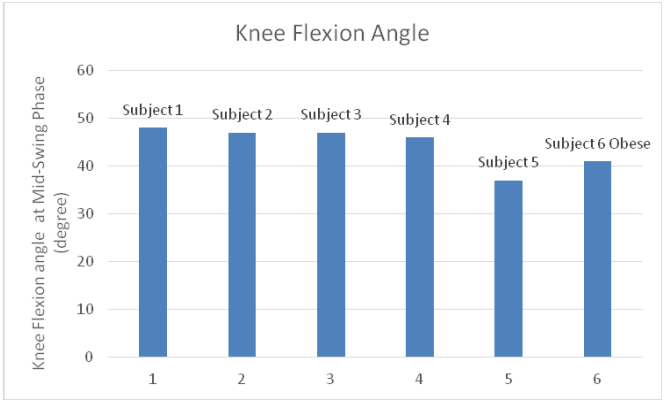

Figure 6: Knee flexion angle of the subjects

It shows clearly that the knee flexion at mid-swing phase decreases among the obese people with respect to the normal subjects. Therefore, this angle could be an indicative parameter of obesity

IV. Conclusion

We have experimentally recorded the walking pattern of normal and obese subjects from EMG instrument and Kinect camera simultaneously in our laboratory. The data was then analyzed. It was observed that the knee flexion angle in the obese subjects is smaller by 30% than the normal subjects.

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