

**Title : Analysis and Evaluation of Walking Pattern for Normal and Diabetic Subjects Using Lower Limb Muscle Activities and Plantar Pressure**

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This paper aims at comparison of walking pattern for normal and diabetic subjects using lower limb muscle activities and plantar pressure. To estimate the peak pressure points on the foot sole, a study was conducted on a group of healthy subjects and it was observed that in case of a normal foot, the peak pressure points are heel, 1st, 3rd, 5th Meta tarsal head (MTH) and toe. Using this data, shoe sole of different sizes were developed with 8 force sensing resistors (FSR) placed in each sole. Foot pressure scanning system was integrated with data acquisition unit BIOPAC MP100 along with EMG machine and connected to computer system. The circuit was designed to match the BIOPAC data acquisition system and 8 add on units of data acquisition system were used for pressure recording purpose. The EMG signals were obtained from 4 lower limb muscles (Tibialis anterior, Gastrocnemius, Peroneus and Soleus), therefore 4 add on modules were added for EMG signal recording. The USB interface was provided between DAS and the computer system. The data recording and analysis was performed using data acquisition software Acq. 3.7.3.

In all 62 subjects were recruited from IIT Bombay and AIIPMR, Mumbai for this study of 21 to 72 years (mean 41.5 years) of age, 40 to 91 kg (mean 65.3 kg) of body weight, 146-179 cm (mean 160.5 cm) of height and 6-8 (mean 7.1) of foot sole size. The subjects were divided in three groups normal control group (N group), diabetic group (D group) and diabetic with neuropathy group (DN group). Total population included 25 subjects from N group and D group each and 12 subjects from DN group. The recording was performed for 30 seconds continuously as one trial and it was saved to system hard disc for off line analysis. Multiple trials were obtained for each subject to ensure that there is no error in data recording.

The data was extracted from raw signal and statistical analysis was performed on the extracted data. Foot pressures (P) have been shown to be affected by the body weight of the subject and hence the pressures normalization was done with reference to the body weight (W) of the subject. The plantar pressure and EMG data was also used for extraction of gait parameters along with standard deviation like duration of heel contact with ground, duration of pressure applied on various pressure heads and mean firing time of Soleus and Tibialis Anterior during a complete gait cycle. The data was normalized by averaging it for one gait cycle on a single time scale in terms of percent time.

The analysis was performed to find the variance in the pressure amplitude on foot sole at various pressure heads for different groups using ANOVA test. It was observed from the analysis results that the population means were significantly different for pressure on Heel, MTH1 and MTH5 however, pressure on other heads was different but not significantly. The gait parameters were observed from the time scale analysis of EMG waveforms and the values were obtained for Mean stride time: 2.14 sec., Mean stance phase: 1.27 sec. and Mean swing phase: 0.87 sec. It was also observed that the stance phase was more and the swing phase was less in DN group in comparison to other two groups.