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Quantitative Gait Analysis of Healthy Adults Using Foot Print Method and Win Track

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Background: *Analysis of gait is an integral part of study of human locomotion. It is an important aspect of health diagnostics, management and rehabilitation of numerous disorders. Various instruments have been developed for the analysis of gait parameters in due course of time. But to test its validity and reliability of is prior importance. Thus the purpose of the present study is to compare the foot print method of gait analysis with Win track platform.*

Objective: *To compare the various quantitative gait parameters using footprint method of gait analysis and Win track platform in healthy adults during bare foot walking.*

Design: *Experimental repeated measures, Convenient sampling.*

Study Setting: *Outpatients department, SBRMH, Lovely Professional University, Phagwara, India*

Participants: *Total 30 healthy participants(14 men and 16 women) were recruited for the study.*

Procedure: *All the subjects wereinstructed first to walk along a smooth horizontal 10 m long walkway. Only the middle five steps were calculated to avoid variability in the steps associated with initiation and termination of the gait. The gait velocity, cadence, step lengths and stride length were calculated for the quantitative gait analysis of the gait parameters. After that, the same subjects were instructed to walk on the WIN TRACK Platform. Three trials were taken for both groups and their averages were obtained.*

Statistical Tool*: SPSS VERSION 16*

Result: *There was a significant difference in the cadence (p value- 0.000), gait velocity(p value – 0.001) and stride length (p value – 0.024). But no significant difference was observed in right step length (p value 0.205) and leftstep length(p value 0 .128).*

Conclusion: *Although WIN TRACK has given almost similar values in terms of step lengths in comparison with foot print analysis, but it was unable to provide similar results in cadence, gait velocity and stride length, which are the integral part of human locomotion.*

Keywords: *Analysis of gait, Foot prints method of gait analysis, Gait parameters, WIN TRACK*

I. Introduction

Gait analysis is an important aspect of human locomotion. Analysis of gait employs to measurement, description and assessment of quantities that characterize human locomotion or gait.[1] Gait analysis helps in the determination of kinetic and kinematic parameters of gait which in turn helps in the quantative analysis of musculoskeletal events occurring during locomotion. Thus gait analysis is an important aspect health diagnostics in the fields of rehabilitation, sports and health care. In sports the analysis of gait helps in improving the faulty athletic performance during the play. [2-6] Similarly in orthopedics gait analysis is done to know the biomechanical deviations during locomotion and also to know the healing progress. It helps in identifying the biomechanical deviations and can act as an important tool for assessment and treatment of musculoskeletal problems in orthopedic rehabilitation. It is an important tool of health medicine too. Gait analysis serve as an important indicator of neurological disease diagnosis, as of the neurological disorders represents a specific gait pattern. Thus gait analysis can act as a precursor for diagnosis. Also it can give the valuable information about the treatment of the disease and thus helps in improving the locomotion of patients. [7-12]

Numerous researches have been done on gait analysis. Gait analysis has become a widespread application in biomedical engineering and has become an area of keen interest among biomedical engineers. [13-17]A standard gait analysis method available is quiet expensive. It makes the use of multi camera motion capture with a force platform which is capable of recording ground reaction force. Although this type of analysis system is installed in many laboratories but it is expensive and limited to research zone only.[18-19]There is one another option available for gait analysis which uses wearable sensors in the shoes or waist of the patient, it is inexpensive and a popular mode of gait analysis.These sensors may be accelerometers, gyrosensors, force sensors, strain gauges, inclinometers, goniometers and soon. [20-21]

Human locomotion is a periodic activity of the body segments which involve the repetitive motions. Normal walking pattern is divided into eight different phases. These phases are: initial contact, loading

response, midstance, terminal stance, pre-swing, initial swing, mid-swing, and terminal swing. Analysis of gait is of function significance because it will tell the motion generated at the different joints and body segments which in turns helps in the assessment, diagnosis and treatment of the particular condition. For the universal acceptance of gait analysis the Rancho Los Amigos gait analysis committee developed a generic terminology for the gait analysis in different phases. [22-26]

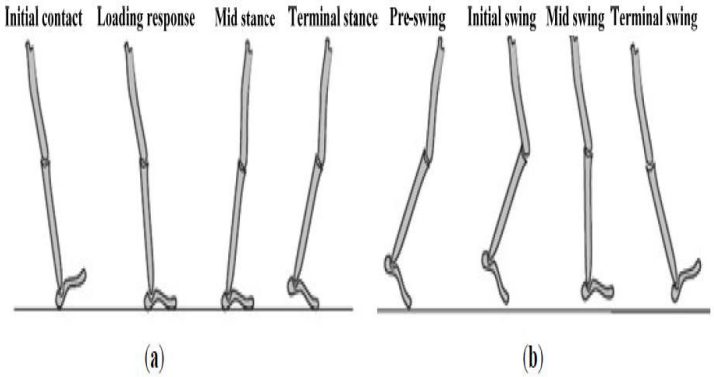


Figure 1: Gait cycle (a) stance period (b) swing period

Win track is a new instrument used for the measurement of planter pressures as well as gait parameters in barefoot walking. This instrument has been used in the research implications but still its validation and standardization needs to be performed. The instrument measures the gait parameters but if the results are reliable or not is needed to be confirmed.

The instrument consists of following dimensions: 1610 mm × 652 mm × 30 mm (length/width/height). The thickness of the platform is 9 mm, and it consists of 12 288 sensors, which are of resistive type. The dimensions of the sensors are 7.8 × 7.8 mm2, and the acquisition frequency of the apparatus is up to 200 images/s. The data obtained from the sensors is directly uploaded on the computer attached to the instrument and the parameters are also computed by the same and the results are displayed on the screen.

Foot prints method of gait analysis is a standard and conventional method for analyzing the spatial parameters of gait cycle. Patient is made to walk after applying blue ink to his feet. Only middle five steps are counted on a 10 meter walkway. And all the spatial gait parameters are calculated.

Analysis of gait is an important aspect of assessment, diagnosis and management of a locomotion disorder. Thus the tool used for the analysis of gait parameters should have validity and reliability. So the present need of the study is to compare the gait parameters using foot print method of gait analysis as a standard with WIN TRACK platform. The study provides an insight that if WIN TRACK can be used as an instrument of choice for the assessment of gait parameters in various conditions.

II. Materials And Methodology:

A total of 30 asymptomatic participants, 20-40 years of age were included in the study. The subjects were taken from Lovely professional university. Age, gender, height (cm), weight (kg) and BMI were determined for each participant at the baseline.There demographic data were collected through individual interview. The inclusion criteria for selection was: (a) Age group of 20-40 years of age; (b) Right leg dominance; (c) BMI ranging from 18.5-24.9; (d) Co-operative and complained in gait analysis; (e) No history of fall; (f) MMSE score above 24. The subjects were excluded if they were having (a) any active medical problem; (b) deformities of spine and lower limb, such as flatfoot, pescavus, genu varum; (c) any neurological disorder; (d) any major orthopedic diagnosis involving lumbar spine, pelvis and lower extremities; (e) using walking aids; and (f) acute medical illness. All the subjects were assessed using MMSE. The study was explained to participants in detail and they were asked to sign a written consent form.

The participants were instructed to walk along a smooth horizontal 10 m long walkway with lateral borders at a comfortable speed. Only the middle five steps were evaluated to avoid the variable steps associated with initiation and termination of gait. The gait velocity, step length, stride length, cadence were measured for quantitative gait analysis. The step length (cm) was measured from the geometrical heel centre of the current footprint to the same of the previous footprint on the opposite foot and stride length (cm) from the line of progression between the heel points of two consecutive footprints of the same foot. The walking velocity (cm/s) was obtained after dividing the recorded distance by the ambulation time. The cadence was calculated by asking the subject to walk for one minute through a straight pathway with self selected speed, then calculating the no. of steps taken during 1 minute. This distance was independent of 10 m walkway. Each participant was given one prior walking before final assessment to become familiarized with walking condition. Footprint method was

used for measuring the spatial gait parameters. Participants were asked to walk after applying blue ink on their feet to get the foot prints demonstrated in figure 2.

Then after the footprint method of gait assessment the same participants were asked to walk on the WIN TRACK system, medicaptures, France. It consists of a platform ofdimensions 1610 mm × 652 mm × 30 mm (length/width/height). Each participant was given one prior walking before final assessment to become familiarized with walking condition as in figure 3.

For both the methods three trials were taken for all the parameters and there averages were obtained. The whole procedure occurred during a single session assessment that last for approximately 30 minutes for each participant.

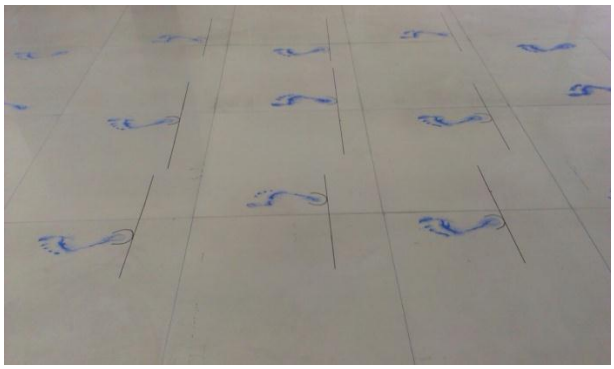


Figure 2: Foot prints method of gait analysis.

Figure 3: Participant walking on WIN TRACK platform

III. Results:

The result of the study showed that there was a significant difference in the gait velocity, cadence and stride length of the same participants when the parameters were analysed using foot prints method of gait analysis and WIN TRACK platform.

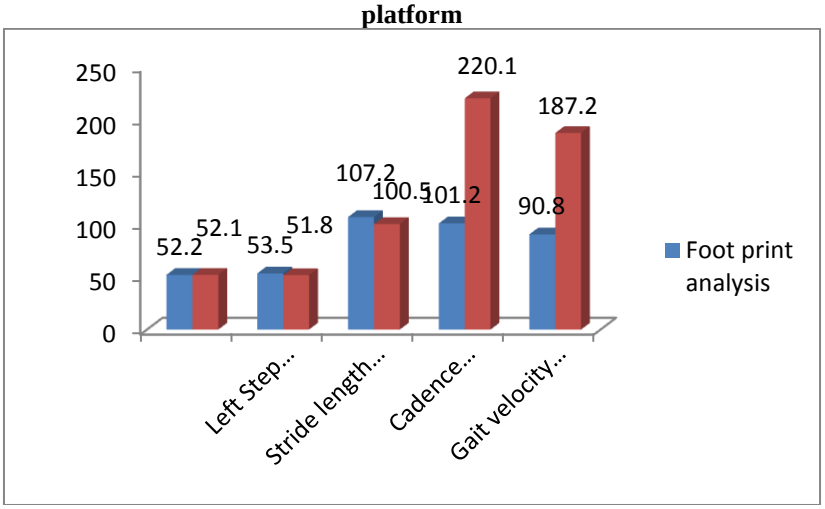
Table 1: Comparison of gait parameters using footprints method of gait analysis and WIN TRACK platform:

Variables	Mean ± SD (Foot prints analysis)	Mean ± SD (WIN TRACK analysis)	t value	p value
Right Step length (cm)	52.2 ± 16.7	52.1 ± 11.5	1.296	0.205 (NS)
Left Step length (cm)	53.5 ± 7.1	51.8 ± 6.1	1.57	0.128 (NS)
Stride length (cm)	107.2 ± 15.2	100.5 ± 12.6	2.39	.024 (S)
Cadence (Steps/min)	101.2 ± 10.2	220.1 ± 55.7	-4.17	.000 (S)
Gait velocity (cm/s)	90.8 ± 16.1	187.2 ± 34.4	-3.89	.001 (S)

S = Significant

NS = Non significant

Figure 4: Comparison of gait parameters using footprints method of gait analysis and WIN TRACK platform



IV. Discussion:

The study included 30 healthy subjects, which were made to walk a 10 m walkway after applying blue ink to their feet and immediately after that on the WIN TRACK. It was ensured that none of the patient was suffering from any kind of pain in the lower limbs or any systemic illness because it may alter the results. All the spatial gait parameters i.e. step length, stride length, cadence and gait velocity were calculated by using both the methods on the same day.

It was observed that there was a much difference between the data obtained by the two methods, which in turn was found with more variability in stride length, cadence and gait velocity. During the gait analysis it was found that while walking on the WIN TRACK when the patient came near the WIN TRACK the patient use to get conscious, which alters his/her gait parameters.. It was also found that it calculates the cadence of the person only based on the three steps taken on it and it gives very high values for the cadence accordingly. Also the surface of the WIN TRACK sheet is very soft. So while barefoot walking when the person came into contact with the sheet it alters his/ her all gait parameters.

Ramachandra et al(2012) stated that WIN TRACK platform 3 steps gait protocol shows better test-retest reliability in terms of gait parameters. So it becomes very difficult for the participant to take 3 steps unconsciously on the WIN track and it further alters the result. If the participant is asked to take three steps only then the participant becomes conscious which further alters the gait parameters.

Shorten et al. 1989, Hughes et al. 1991, Rosenbaum et al. 1994, and Kernozek et al. 1996 proved that as the walking velocity increases the plantar pressure decrease at lateral foot, forefoot and mid toe, but it remains constant or increases at the sole of foot. This may be probably the reason that when participant walks with a particular velocity if plantar pressure is not detected by the sensors of the platform it will not record the readings of the particular parameters. As sometimes while taking the readings it was observed that participant has taken three steps but WIN TRACK platform was not able to record that.

V. Conclusion

The data obtained from the study revealed that a marked difference was seen in the gait parameters namely gait velocity, cadence and stride length when a comparison was made analyzing the gait parameters with a conventional method of footprints and WIN TRACK. Although there were no significant changes seen in the step length (right) and step length (left) statistically, but statistically insignificant differences were seen in these both parameters also. Future studies must be conducted on the patients with loss of sensation under the feet. Also studies must be conducted by embedding the WIN TRACK platform in the same surface of pathway and same color of pathway as well as platform. So as the participant should not get conscious during the protocol. Emphasis should also be made on the surface of the platform to make it as rigid as the walkway or vice versa such that it should be almost similar to the pathway.

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