

Biomechanical Analysis of Different Forms of Female Walking

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Abstract

Introduction: Walking is a fundamental activity for human being. Mainly there are three types of walking viz. Normal Walking, Race Walking and Marching. While normal walking is used for locomotion, Marching is used by the army and police personnel for locomotion in a disciplined manner and race walking is a competitive sport. In the process of walking leg movements are primary but the arm movements have also important role. The purpose of the present study was to analyze and compare some selected mechanical parameters of these three forms of walking and compare them.

Methods: For the present study fifteen females from different groups of walking were selected as the subjects. Among them five were National level NCC cadets, five were National level race walkers and the rest five were normal females. The movements of all three types of walking were recorded using video-graphic technique. Afterwards the recorded movements were projected frame to frame and kinegrams were drawn. From the kinegram the kinematic parameters were analyzed using appropriate software. Selected kinematic parameters were velocity of Cg, movement amplitudes of leg and arm.

Results and Discussion: Mean velocity of Race Walking was 3.98m/s, Normal Walking 1.35m/s and Marching 0.99m/s. Mean Stride Length for Race Walking was 1.17m, for Normal Walking was 0.69m and for Marching 0.50m. The mean Arm Amplitude for Race Walking was 117.40, for Normal Walking 64.60, and for Marching 170.20. All the inter-group differences were statistically significant at 0.01 level.

Conclusion: On the basis of results, following conclusions were drawn. The velocity of the main body and leg amplitude were maximum for the race walking and minimum for marching-group.

Keywords: *Walking, Marching and biomechanical analysis.*

Introduction

Walking is a fundamental racial activity for human beings. A child learns walking in natural process of growth and development and performs it throughout life. Leg movements are the primary movements for this locomotion process. But, a close look into the movement structure of walking clearly indicates that the arms also move in certain coordinative pattern of leg movements. Many studies have been conducted to analyze the gait pattern of individuals, where the arm movements have also been studied. General conclusions drawn in most of these studies emphasize the characteristics and contribution of arm swing to the leg movements as well as the movements of the whole body. By nature arm swing movements are just opposite in direction of the leg movements. Thus, the left arm swings forward with the forward movement of right leg. The main purpose of arm movements, as has been concluded, is to help the body to maintain balance during the process of locomotion.

Walking has many forms- normal walking, race walking, marching etc. With the change of form, the arm movements also alter in these cases. Present study was planned to study and analyze the nature of some selected kinematic parameters of arm movements in the three different forms of walking as mentioned above in relation to the leg movements and total body movement, and to compare them.

Methodology

A total of fifteen college females were selected as subject for the present study, out of five were the subjects for race walking, another five were the subjects for marching group and the rest five were the subject for normal walking group . The race walkers were the national level performers and the subjects for marching group were N.C.C. 'C' certificate holders. Another five college female students were considered as the subjects for normal walking.

The selected kinematic parameters for this study were velocity of the main body, amplitude of arm swing movements and stride length during three different forms of walking. The movements of three different forms of walking of the subjects were recorded by a digital camera by following the basic principles of scientific filming. Later on, the recorded

movements were projected by an improvised projector capable of projecting in freeze frame condition. Silicon coach trail version was used for analysis.

The kinegrams of the movements of different forms of walking of the subjects were drawn. With the help of the knowledge of camera frequency and the linear distance measuring unit, the (position-time) information for the points of interests were obtained. From this basic information the displacement time (s-t) information and velocity-time (v-t) information were derived by graphical differentiation method.

The data regarding selected kinematic parameters were analyzed using standard statistical procedures. The mean was calculated as the measure of central tendency and the standard deviation was calculated as the measure of variability. Significance of difference among mean values was tested by Analysis of variance and exact location of the difference was identified by suitable post hoc test.

Results and Discussion

Mean and standard deviation of selected parameters for three different forms of walking have been presented in **table-1**. It is seen from the table values that the Velocity of the main body

Table-1

Mean and SD of the selected Kinematic parameters

Sl. No	Kinematic parameters	Mean and SD of		
		Normal Walking	Race Walking	Marching
1.	Main body velocity (m/s)	1.348 ± 0.10	3.98 ± 0.45	0.99 ± 0.038
2.	Stride length (m)	0.69 ± 0.054	1.17 ± 0.029	0.51 ± 0.042
3.	Arm amplitude (degree)	64.6 ± 12.48	117.4 ± 8.295	170.2 ± 3.89

to movement during race walking was maximum with the mean value of 3.986 ms⁻¹. The velocity of marching and normal walking was almost same. The stride length was also

maximum for race walking. But the stride length of normal walking appeared to be greater than that of marching. The arm amplitude was maximum for marching with the mean value of 170.2° and minimum for normal walking with the mean value of 64.6° . This indicates that the main body velocity during race walking becomes maximum among different forms of walking but the arm amplitude becomes maximum for marching.

In order to the significance of difference among mean values of different selected kinematic parameters, Analysis of variance technique was used. The results have been presented in **Table-2**. It is seen from the table values that there were statistically significant

Table-2

ANOVA for mean values of selected kinematic parameters

Sl. No.	Kinematic parameters	F- value	Remarks
1.	Main body velocity	185.03	Significant at 0.01 level
2.	Stride length	321.82	”
3.	Arm amplitude	174.39	”

differences among the mean values of all the selected kinematic parameters. In order to find out the exact location of the difference among mean values, t-values for pair means were calculated. **Table-3** represents the results. It is clearly seen from the table values that the

Table – 3

Results of t –test for pair means of three different forms of walking

VELOCITY OF THE MAIN BODY	M_1 vs M_2	$P < .01$	M_1 = Mean of Normal Walking Group.	HSD= absolute (unsigned) difference between any two sample means required for significant at the designated level. HSD [.05] for the .05 level;
	M_1 vs M_3	Non-significant		
	M_2 vs M_3	$P < .01$		
STRIDE LENGTH	M_1 vs M_2	$P < .01$	M_2 = Mean of Race Walking Group.	
	M_1 vs M_3	$P < .01$		

	M ₂ vs M ₃	P < .01	M ₃ = Mean of Marching Group.	HSD [.01] for the .01 level;
ARM	M ₁ vs M ₂	P < .01		
AMPLITUDE	M ₁ vs M ₃	P < .01		
	M ₂ vs M ₃	P < .01		

velocity of the main body was significantly greater for race walking than normal walking and marching. But the difference between normal walking and marching was not statistically significant. Similar results have been seen for stride length also. It was significantly greater for race walking than other two forms. But the difference between normal walking and marching was not statistically significant. Regarding arm amplitude the mean value for marching was seen to be significantly greater than both— normal walking and race walking. This parameter for race walking was also significantly greater than normal walking.

As per mechanics, the arm movements are compensatory movements of leg movements during walking. The results of the study show that the velocity is maximum for race walking and minimum for marching. So, the very high value of arm amplitude for marching proves the unnatural characteristics of the form of walking. Basically, race walking and marching- both are deviations from the normal walking. But in race walking the technique is developed to increase the velocity of main body. In marching there is a deliberate attempt to decrease the velocity of the main body. The main emphasis here is to develop correct form of movement only.

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