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Static and dynamic balancing and gait training in shooters leading to a better efficacy: A prospective study

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Abstract

Shooting is a sport of precision that requires balance, and due to the repetitive nature of the sport it needs high endurance as well. Although it is static sport injuries may be experienced from doing the same thing over and over again, thus putting a toll on the body physically.

Interventions provided by orthopaedicians /physiotherapist can be very beneficial for a shooting athlete. Postural alignment, flexibility, strength, postural stability, biomechanics and the evaluation and treatment of acute and chronic musculoskeletal impairments are important considerations to a high performance in sports shooting.

Postural alignment and gait analysis is very important. A misalignment of the foot and ankle can cause injury of the ankle, shin, knee, hip, and lower back.

In our study at Abhinav Bindra Targeting Performance we have taken into consideration the professional shooters on which gait assessment was done before and after the training session. This study will help us know the benefits of training a specific group of muscles for strengthening and improves the efficacy of the athlete.

Keywords: dynamic balancing, gait training, better efficacy

Introduction

The ability to walk upright is a defining characteristic of man. Gait is the manner in which walking is performed and can be normal, antalgic, or unsteady^[1]. Gait analysis can be assessed by various techniques but is most commonly performed by clinical evaluation incorporating the individual's history, physical examination, and functional assessment. Gait abnormalities can be more precisely examined through the use of gait laboratories. These laboratories utilize surface EMG activity of muscles, force plates, and kinematic evaluation of the lower limbs. They are highly specialized units that assess various gait abnormalities from individuals with neuromuscular disorders to high-level athletics. A proper clinical evaluation should always precede any gait lab assessment^[2].

The determination of abnormal gait requires one to first have an understanding of the basic physiology and biomechanics of normal gait^[3]. The gait cycle is a time interval or sequence of motion occurring from heel strike to heel strike of the same foot. The gait cycle has been broadly divided into two phases: stance phase and swing phase. These phases can then be further subdivided and discussed in terms of percentage of each within the gait cycle.

The stance phase is 60 percent of the gait cycle and can be subdivided into double-leg and single-leg stance. In double-leg stance, both feet are in contact with the ground. At an average walking speed, it represents 10percent of the entire gait cycle, but decreases with increased walking speed and ultimately disappears as one begins to run. At slower walking velocities the double-leg support times are greater. Single-leg stance comprises up to 40 percent of the normal gait cycle^[4]. The muscles that are active during the stance phase act to prevent buckling of the support limb. These include the tibialis anterior, the quadriceps, the hamstrings, the hip abductors, the gluteus maximus, and the erector spinae. The swing phase is described when the limb is not weight bearing and represents 40 percent of a single gait cycle. It is subdivided into three phases: initial swing (acceleration), mid swing, and terminal swing

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(Deceleration). Acceleration occurs as the foot is lifted from the floor and, during this time, the swing leg is rapidly accelerated forward by hip and knee flexion along with ankle dorsi flexion. Midswing occurs when the accelerating limb is

aligned with the stance limb. Terminal swing then occurs as the decelerating leg prepares for contact with the floor and is controlled by the hamstring muscles.

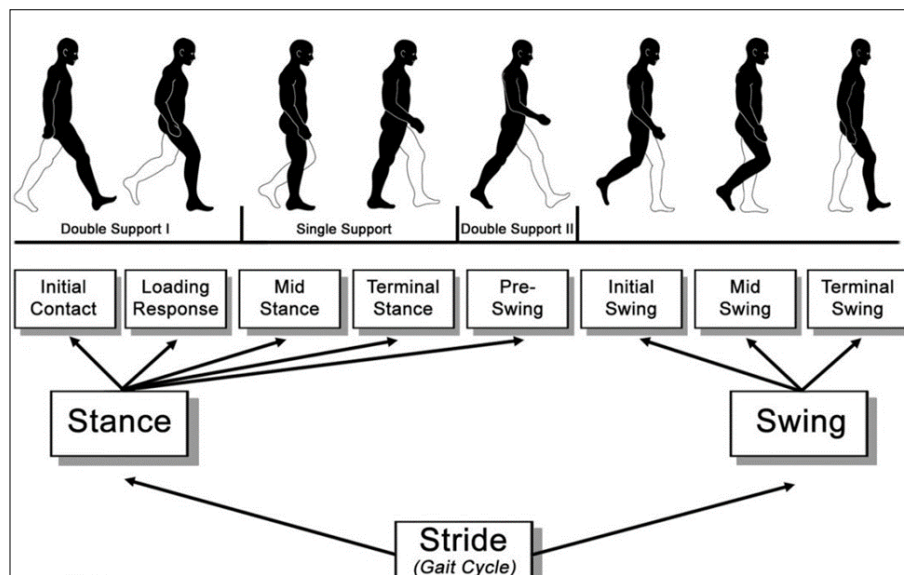


Fig 1: Show the stance, stride and swing

Determinants of gait and energy conservation

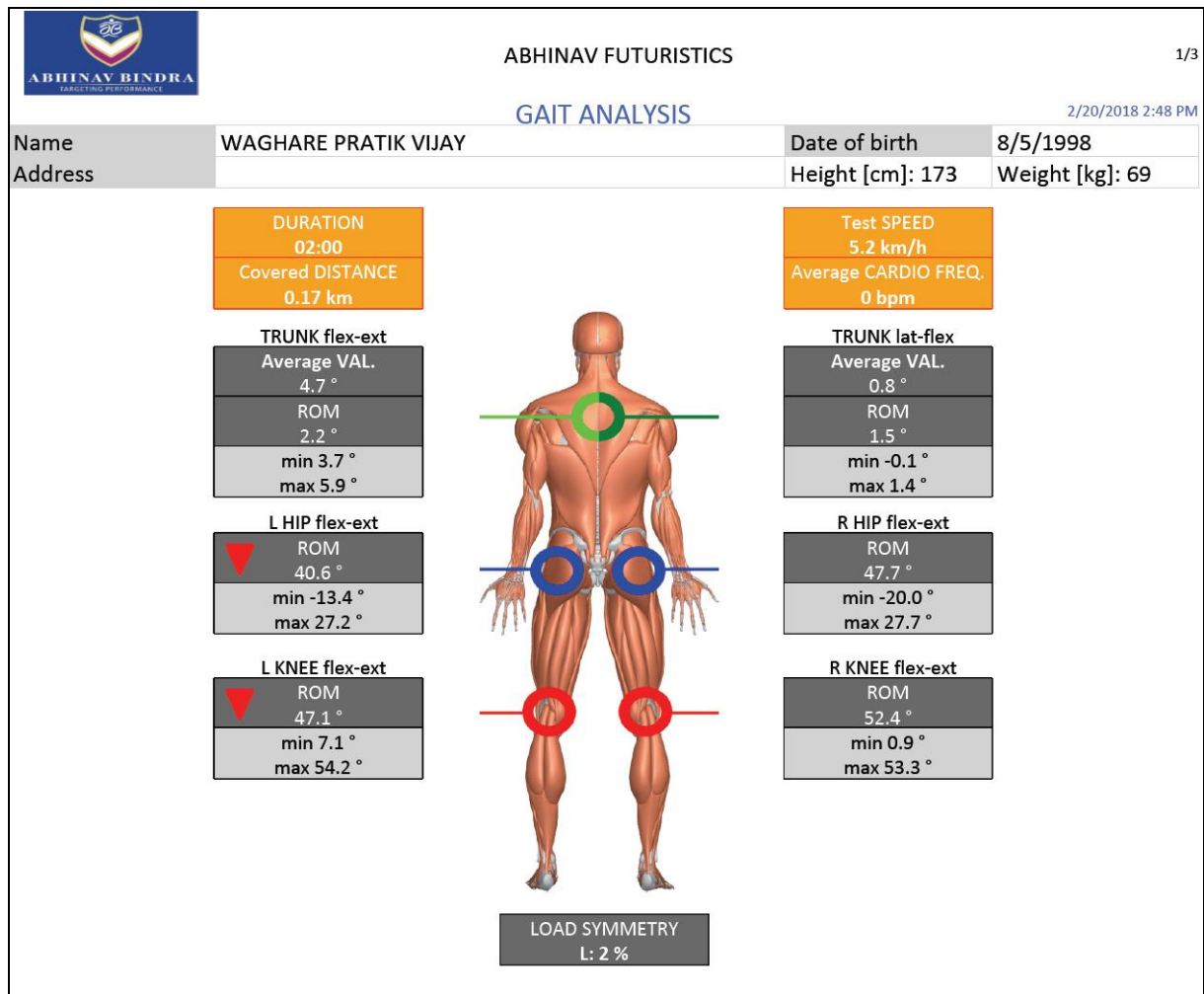
During gait, three main events occur in which energy is consumed. This includes controlling forward movement during deceleration toward the end of swing phase, shock absorption at heel strike, and propulsion during push off, when the center of gravity is propelled up and forward. A human's center of mass (COM) is located just anterior to the second sacral vertebra, midway between both hip joints. The least amount of energy is required when a body moves along a straight line, with the COM deviating neither up nor down, nor side to side. Such a straight line would be possible in normal gait if man's lower limbs terminated in wheels instead of feet. This obviously is not the case, thus, our COM deviates

from the straight line in vertical and lateral sinusoidal displacements. With respect to vertical displacement: the COM goes through rhythmic upward and downward motion as it moves forward. The highest point occurs at midstance, the lowest point occurs at time of double support. The average amount of vertical displacement in the adult male is approximately 5 cm. With respect to lateral displacements: As weight is transferred from one leg to the other, there is shift of the pelvis to the weight-bearing side. The oscillation of the COM amounts to side-to-side displacement of approximately 5 cm. The lateral limits are reached at midstance. Any pathology that increases the vertical distance between the high and low points, increases the energy cost of ambulation.

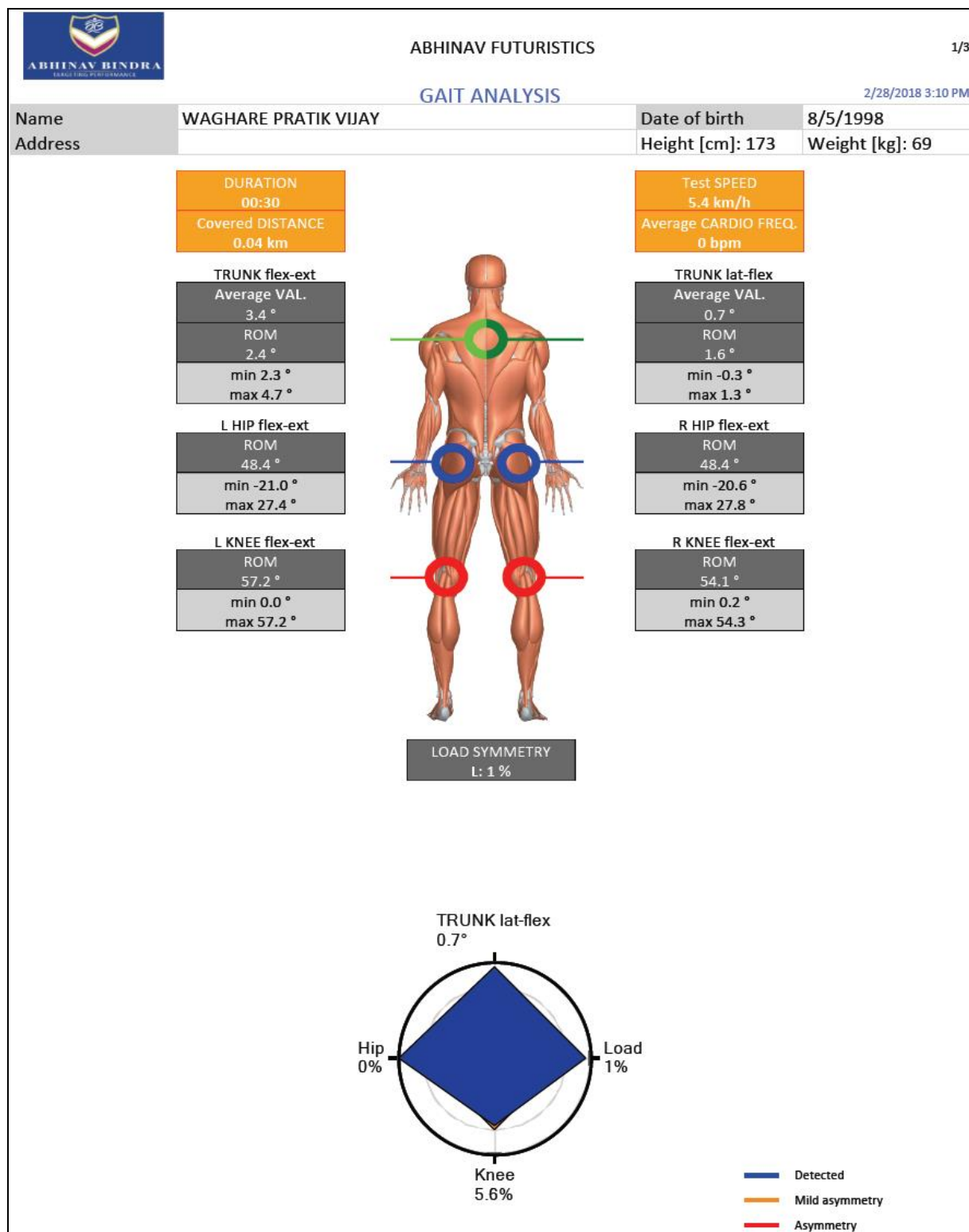
Determinant	COM Displacement	Effect
First Pelvic Rotation About the vertical axis, alternating to the right and to the left relative to line of progression	Decreased 4° of each side from a total of 8° Reduces the drop in COM during double limb support	Energy conservation saves the COM drop at its lowest point 6/16 inch (elevates end of arc)
Second Pelvic Tilt At horizontal axis at midstance	Reduces the peak of COM during single limb support	Energy conservation by shortening the pendulum of the leg (3/16 inch) at the high part of arc (depresses summit arc)
Third Knee flexion in stance	High point of COM further reduced by knee flexion in midstance	Energy conservation by decreasing rise of arc (7/16 inch) by walking over a bent knee (depresses summit arc)
Fourth & Fifth Foot and ankle mechanism	Combination of foot and ankle motion with knee motion smoothes the COM change in direction	Flattens and slightly reverses arc of translation (decreased 3/16 inch)
Sixth Lateral displacement of pelvis	Must bring COM above support point to balance on one leg	Lateral displacement of the pelvis is largely abolished by the presence of the tibial-femoral angle. There is a side-to-side sway of 1.7 inch radius

COM = Center of Mass

Determinants of Gait [5]



Pre training



Post training

Methodology

A total of 32 shooters were examined clinically and gait analysis was performed on them thereafter with a proper consent for participation in the study at Abhinav Bindra Targeting Performance, India from a period of January 2019 to may 2019.

Aims and Objectives

-gait analysis and pelvis muscles assessment for shooters prior to training and comparing the assessment post training
-effect of stability and strengthening for improving the efficacy of the shooters

Discussion

The analysis of pre and post static balance as well as dynamic balance for both groups and the comparison of the post balance test of two groups were analyzed by using independent sample t-test.

First of all, the GAIT assessment scoring of firm surface before the study among the control group was 5.14 ± 1.069 and increased to 5.39 ± 1.704 , which did not show significant at 5% level of significance ($p > 0.05$). while the scoring of foam surface before study was 7.79 ± 0.851 and increased to 7.53 ± 1.372 , therefore it was not significant at 5% level of significance ($p > 0.05$).

On the other hand, the scoring of GAIT assessment for firm before the intervention among the experimental group was 5.34 ± 1.269 and after the intervention training program, it reduced to 2.90 ± 1.190 which showed significant improvement with $p < 0.05$.

The dynamic balance results were reported on left and right stance. The higher the score the better the dynamic balance of the individual.

The shooters scores of mean and standard deviation of left stance before the study among the control group before test was 77.36 ± 4.137 and after test score was 74.79 ± 7.156 , which the improvement did not show statically significant; whereas in right stance, before test was 76.37 ± 6.785 and after test was 72.58 ± 7.960 after four weeks of study and the improvement did not show statically significant. However, the score for experimental group in left stance was 75.31 ± 5.334 before the intervention and improved to 82.14 ± 5.661 after a month intervention training, and it was significant at 5% level of significance ($p < 0.05$). Meanwhile, the scoring of in right stance increased from 77.12 ± 7.015 to 86.29 ± 5.795 before and after intervention respectively. Thus, this showed that the result of left stance and right stance in SEBT indicated significant improvement ($p < 0.05$). Meanwhile, for standing on firm surface, the mean score for the experimental group was 3.20 ± 1.191 and for the control group was 5.79 ± 1.504 . The result indicated there was significant difference between the pre training and post training after a months study.

Results

The combination of the two exercises components in current study which were the balance exercises and jump landing training, gait training and static and dynamic balancing on firm and foam surface have drastically improved the ability of shooters to balance and aim accurately [6]. Thus, it is crucial that balance training should continue to be studied and promoted to ensure the improvement in static and dynamic balance and thus reducing the risks of injuries such as knee and ankle injuries and also ensure the accuracy of shooters.

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