Original Article

Comparison of gait kinematics and kinetics between qualified dancers and non-dancers

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Abstract

Problem statement. Many people practice dance and we can see the difference in gait patterns between professional dancers and non-dancers in different previously studies, but there are many people who practiced dance in a not professional way for many years. So the question is: are there differences in gait patterns also in people who practiced dance in a non-professional way? **Purpose:** The purpose of this paper is to evaluate the difference, in gait patterns, between qualified dancers and non-dancers using an optoelectronic system and force platforms. The dancers in question are not professional, but we want to evaluate if there are difference in gait patterns in women who practiced dance for many years. **Methods.** The sample is composed of six female dancers, average age 22.83 years, average height 163.83 cm and average weight 56 Kg. The dancers performed 10 walking trials at their preferred speed. The kinematic and kinetic data have been recorded with an optoelectronic motion system (BTS Bioengineering) and two force platforms positioned at the middle of the walkway. The markers have been positioned following the Davis protocol. SMART software has been used to process the tests and to create the final report. **Results:** There are no significant differences in gait patterns except about the double support and the width of the step. All data differ from normality with a percentage less than 5%, but double support differs more (right cycle 9,85%, left cycle 7,22%) such as step width (60,51%). About kinematics on the sagittal plane, we see differences in the pelvic tilt which moves foreversion for all the cycle and in ankle because during dorsiflexion it is always a little more during the two peaks ($\approx 40\%$; $\approx 80\%$). On transverse plan, we can see a little increase in internal rotation of the knee and an extra-rotation in foot progression. About kinetics, we have data only about the sagittal plane. It just shows a delay in vertical GRF between the 10% and the 20% of the cycle. **Discussion.** We can assert that all these modification of gait patterns originate from the activity that dancers carried out. All of these are attributable to a compensation that they execute for a more efficient gait. **Conclusions.** Looking at the data we can assert that these are very interesting because, as we supposed, we can see differences at pelvis, knee and ankle/foot. It should be important to have a larger sample to have more data for a better comparison

Key words: motion analysis, gait, dancers.

Introduction

Gait is an activity that people do thanks to nervous impulse sent from the neurons to the muscles to move the articulations, the limbs and the whole body (Whittle M. W., 2012). Many studies in the early of '900 showed the role of sensorial feedback during the motor skills, like the gait. Our brain uses sensorial feedback to do some adjustments during gait to make gait more fluid. There are, also some external forces that influence our movements and our brain is responsible of the Anticipatory Postural Adjustments (APAs) (Rosenbaum, 2010). There are many articles or studies about gait patterns in dancers, but most of dancers in this kind of articles are professional as for example in Janura (2018). The greatest majority of dancers that you deal with in the everyday life are not professional, so the purpose of this research is to evaluate how different are these gait patterns. There are no data about how many dancers become professional in Italy or in Europe, the only data about it concerns in how many artists become professional in USA (Jahoda, 2014). Dance is an activity that demands a very hard work of the musculoskeletal system (Teplá et. al 2014) and most of the exercises or positions that they assume during training and competitions can change their stability. Many studies demonstrate that dance causes a hypermobility in certain joints (Howard A. Bird, 2016) and neuromuscular activity has a key role in joint protection (Iunes, 2016). Iunes *et al.* (2016) also found that female ballet dancers had in stance larger hip external rotation and increased lumbar lordosis than non-dancers. Considering that, the purpose of this study is to evaluate the differences between qualified dancers and non dancers in gait patterns.

Methods

The sample was put together from six qualified dancers (age: $22,83 \pm 1,47$ years; height $163,83 \pm 4,88$ cm; weight $56 \pm 7,07$ Kg). For kinematics has been used an optoelectronic system with six infrared cameras, two force platforms (BTS P6000) and the 22 markers have been positioned according the Davis protocol (Davis, 1991): c7, left and right acromion, s1, left and right anterior superior iliac spine, left and right trochanter, left and right femoral condyle, left and right head of the fibula, left and right malleolus, left and right heel, left and right fifth metatarsal head and, lastly, four bars a the middle of left and right thigh and calf. After the calibration of the system, the dancers, walked on the walkway many times to have, at least, ten good acquisitions for every dancer. Next step was the tracking of every acquisition with SMART Tracker. With this program, we get the chance to evaluate every acquisition and cut the not useful frames. Then has been developed the protocol to process kinematics and kinetics with SMART Analyzer and has been developed the protocol to obtain the report too. After the launch of the protocol, the only thing to do is select the events of contact and the detachment between them and you have to pay attention with it. About the statistic we have calculated the difference between the data we employed and the normality.

Results

In Table 1 we have all the data about time parameters express in seconds or in percentage about the whole gait cycle.

Table 1. Time parameters

	Right	Left	Normality
Cycle time [sec]	$1,072 \pm 0,096$	$1,059 \pm 0,09$	$1,103 \pm 0,094$
Step time [sec]	$0,641 \pm 0,065$	$0,635 \pm 0,064$	$0,653 \pm 0,067$
Swing time [sec]	$0,431 \pm 0,032$	$0,424 \pm 0,028$	$0,441 \pm 0,053$
Step [%]	59,712	59,862	58,98
Swing [%]	40,288	40,138	40,03
Double support [%]	9,258	9,528	10,27

In Table 2 there are the spatial parameters express in meters. Looking at the sagittal plane we see differences in the pelvic tilt which moves foreversion for all the cycle (*Chart 1*) and in ankle because during dorsiflexion it is always a little more accentuated during the two peaks ($\approx 40\%$ and $\approx 80\%$ of the gait cycle) .

Table 2. Spatial parameters

	Right	Left	Normality
Cycle length [m]	$1,266 \pm 0,052$	$1,27 \pm 0,059$	$1,358 \pm 0,108$
Step length [m]	$0,651 \pm 0,023$	$0,617 \pm 0,033$	$0,619 \pm 0,046$

Chart 1 – Pelvic tilt

Chart 2 – Ankle dorsiflexion

legend

On transverse plan, we can see a little increase during all rotation of the pelvis (*Chart 3*), an internal rotation of the knee (*Chart 4*), a pronounced extra-rotation of the hip (*Chart 5*) and an extra-rotation in foot progression (*Chart 6*).

Chart 3 – Pelvic rotation

Chart 4 – Knee rotation

Chart 5 – Hip rotation

Chart 6 – Foot progression

About kinetic we have data only about the sagittal plane. It just shows a delay in vertical GRF between the 10% and the 20% of the cycle (*Chart 7*). All these data have a distance to the normality less than 5%, except

some of them: double support (right cycle -9,85%, left cycle -7,22%), cycle length (right -6,77%, left -6,48%), the length of the right step (+5,17%) and, especially, the width of the step (-60,51%). All these data are the average of the whole collected data.

Chart 7 – Vertical GRF

Discussion

Many studies demonstrate that there are differences in gait patterns in dancers with injuries (Macintyre J., 2000) or during rehabilitation. This because of the compensation. This means that every activity people carry out during their life involve a modification of the posture in static and in dynamic. Dancers apply compensation during their gait cycle. The activity they carried out caused some differences in their motor skills and the compensation that they execute is to make their gait as effective as possible. The charts show differences at hip joint that move external, at knees which increase intra-rotation and at feet that move with an extra-rotation during all the cycle. They also show a continuous foreversion of the pelvis. Our body always tries to do anything in the way we expend less energy as possible (Perry J., 1995). Obviously these modifications are necessary to execute the movements in dance in the right way, but dancers, such as every athlete, modify their gait too in the way their gait is efficient.

Conclusions

As we supposed there are some differences in gait patterns such as the external rotation of the hip joint, the intra-rotation of the knees, the external rotation of the feet and the continuous foreversion of the pelvis. This study gave us a great inspiration for next researches. It should be interesting to increase the number of people composing the sample to have a better consistency, introducing a sample composed by men and the electromyography as well.

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