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PROFESSIONAL BALLET DANCERS' POSTURAL CONTROL IN A *PASSÉ EN DEMI-POINT* POSITION

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SUMMARY

Classical Ballet is an activity in which balance control is essential to perform tasks that are highly demanding and of motor complexity. The *passé* position is among the most frequent positions in ballet, besides being the starting point for movements such as the *pirouette*. Assuming the hypothesis that ballet dancers show greater oscillation in a smaller base and with visual restriction, the objective of the present study was to assess the postural oscillation of ballet dancers in the *passé en demi-point* position. Fourteen professional ballet dancers were recruited, with a mean age of 28.4 (SD 10.8) years. The postural control analysis was performed using an AMTI force platform. Center of Posture (CoP) was used to obtain the variables: velocity (cm/s); dislocation (cm); mean dislocation (cm); area of CoP oscillation in the positions: unipodal control position with and without visual restriction, and *passé en demi-point* position, on the dominant limb. The positions were compared using ANOVA with a significance level at 5% and post hoc Dunnett's test, using as reference the unipodal position without visual restriction. Results point at greater oscillation in the unipodal position with visual restriction. Furthermore, it was observed that in the *passé en demi-point* position there was an increase only in mean and medio-lateral CoP velocity compared to the baseline position. Therefore, professional ballet dancers exhibit higher visual dependency to maintain their balance, and the support base had a small effect on the postural control of those athletes.

INTRODUCTION

Postural balance regards the skill of maintaining the body's position, namely the center of mass, within the limits of stability through an interrelation of the forces acting over the body, and depending on the sensory information provided by the vestibular, visual and somatosensory systems so that motor actions be executed [1,2].

Classical Ballet is an activity which balance control is key in performing movements that are highly demanding and of motor complexity, which are commonly performed by those athletes [3,4]. Ballet dancers are trained to use their sight as a reference of space, and, thus, this sense is important in their balance maintenance, either static or dynamic [3,4,5,6]. In terms of the support base, ballet dancers are required to perform most of their movements in a *demi-point* and *point* position, with the *passé en demi-point* being the most frequent initial position for complex movements such as the *pirouette* [7].

The study hypothesis is that ballet dancers present greater oscillation in a smaller base and with visual restriction compared to a unipodal position without visual restriction. The study objective was to assess the postural oscillation of ballet dancers in the *passé en demi-point* and unipodal position with and without visual restriction.

METHODS

Fourteen professional ballet dancers, male (n=2) and female (n=12), were recruited. The mean age of the dancers was 28.4 (SD 10.8) years, and their mean time as professional ballet dancers was of 20 years. The following inclusion criteria were used: professional athletes working in the state of Rio de Janeiro/Brazil, with no vestibular alterations or balance disorders, no injuries, and not be undergoing rehabilitation during the test period.

The data regarding the dislocation of the center of pressure (CoP) were obtained using an AMTI (Watertown, MA/USA) force platform, of model *Accus Sway PLUS*®, with a sampling frequency of 1000 Hz, connected to an acquisition and data processing system *Suite*EBG® 1.0.0.1 (Rio de Janeiro, Brazil).

The positions performed to analyze static balance were executed on the dominant limb and divided into: 1) unipodal control position(UCP), in which the dominant limb was used as support with the opposite limb at 90^o knee flexion and the hip in neutral position, without visual restriction and arms on the side of the body (UCPOE); 2) unipodal position with visual restriction (UCPCE), in which the ballet dancer was blind-folded and instructed to remain with eyes closed throughout the test; 3) *passé en demi-point* position (PDPP), performed only without visual restriction because of the high level of difficulty to remain in this position. Subjects were asked to remain as steady as possible in every position. The UCPOE and UCPCE positions were performed for 35 seconds, with the first 15 seconds being regarded as the adaptation period. The *passé en demi-point* position was performed for 20 seconds, and the first 5 seconds considered the adaptation period. The adaptations periods were disregarded in the analysis [6,8]. Each task was repeated three times, at random, and with a one-minute interval between them.

The data regard CoP dislocation was processed with 100 Hz frequency and using a 2.5 Hz second-order low-band filter.

The following variables were used to analyze postural control: mean CoP velocity (cm/s), peak anterior-posterior CoP velocity (cm/s) and medio-lateral CoP velocity (cm/s), anterior-posterior CoP dislocation (cm) and medio-lateral CoP dislocation (cm), mean CoP dislocation in the horizontal plane (XY) (cm) and area of CoP oscillation (cm^2). Data analysis was performed considering the mean value of the three repetitions of each position. Statistical analysis was performed using one-way ANOVA and post hoc Dunnett's test, considering UCPOE as the reference position, and a significance level of 5%.

RESULTS AND DISCUSSION

By comparing the UCPOE and UCPCE positions, it was observed that with visual restriction every oscillation pattern of the ballet dancers increased (table 1). Regarding the support base, when compared to the UCPOE and PDPP positions, only the mean CoP velocity and peak medio-lateral CoP velocity increased when the support base was reduced (table 1).

Our data are in agreement with those observed by Bruyneel et al. [4], who demonstrated an increase in postural oscillation in ballet dancers in positions performed with visual restriction. Perrin et al. [3] demonstrated that ballet dancers show greater oscillation associated to visual restriction compared to athletes of different modalities, thus it is observed that ballet dancers are more dependent of their sight in order to maintain their balance. This fact is likely due to differences in the training of these athletes, as they are trained to use their sight throughout every movement for their location and marking their heads in the setting [4].

The support base is another factor likely to affect postural control. According to our data, the support base had a small effect on postural oscillation; however, our reference position was the unipodal position, which has been associated with increased instability [7]. Hence, we believe that the *passé en demi-point* position was not challenging compared with the unipodal position.

Lobo da Costa et al. [7] found increased medio-lateral CoP dislocation in ballet dancers with a history of ankle sprains, compared to non-dancers. Our data are in agreement with these findings, as it is observed there was an increase in the peak medio-lateral CoP velocity in the PDPP. Bruyneel et al. [4] reported that this difference in the oscillation of ballet dancers could be related with their training performed with the lateral support, thus affecting the muscular responses to mediolateral oscillation.

The present study data offer partial support to our hypothesis, as a smaller support base (PDPP) affected only the mean CoP and peak medio-lateral CoP velocities of the ballet dancers.

CONCLUSIONS

The present study data demonstrated an increased postural oscillation with visual restriction in the unipodal position; however, regarding the smaller support base (PDPP) only an increased medio-lateral CoP velocity and mean CoP velocity were observed.

REFERENCES

1. Mann L, et al. *Motriz*. **15**: 713-722, 2009.
2. Emery CA. *J Sci Med Sports.* **6**: 492-504, 2003.
3. Perrin P et al. *Gait Posture.***15**: 187-194, 2002.
4. Bruyneel AV et al. *Neurosci Lett.* **485**: 228-223, 2010.
5. Haas AN et al. *Braz J Sports Med.* **16**: 182-185, 2010.
6. Cheng-Feng L et al. *Am J Sports Med*. **39**: 1324-1331, 2011.
7. Lobo da Costa PH et al. *Gait Posture.* **Sep 16**, 2012 [Epub ahead of print]
8. Nolan L and Kerrigan DC. *Gait Posture.***19**: 11-15, 2004

Table 1: Mean and confidence interval of the postural oscillation variables in the control positions without visual restriction (CPOE), with visual restriction (CPCE) and a passé en demi- point position (PSPP) in ballet dancers.

Stabilogram Parameters			
	CPOE	**CPCE**	**PDPP**
Mean CoP velocity (cm/s)	3.02 (2.53; 3.51)*, [b]	8.03 (6.03; 10.03)	6.44 (5.2; 7.67)
Peak anterior-posterior CoP velocity (cm/s)	28.43 (20.3; 36.57)*	69.8 (52.9; 86.74)	28 (19.48; 36.49)
Peak medio-lateral CoP velocity (cm/s)	15.36 (12.22; 18.5)*, [b]	51.4 (39; 63.81)	29.03 (22.49; 36.02)
Anterior-posterior CoP dislocation (cm)	2.28 (1.99; 2.57)*	6.2 (5.16; 7.2)	2.66 (2.04; 3.29)
Medio-lateral CoP dislocation (cm)	1.73 (1.48; 1.99)*	5.12 (4.17; 6.1)	2.49 (1.98; 3.0)
Mean CoP dislocation (cm)	90.73 (76.14; 105.33)*	241.05 (181.2; 300.9)	94.92 (76.44; 113.4)
Area of CoP oscillation (cm^2)	1.54 (1.17; 1.91)*	9.48 (7.02; 11.94)	2.89 (1.52; 4.25)

* Statistical difference between CPOE and CPCE; [b] Statistical difference between CPOE and PDPP.