VALIDATION OF THE PHOTOELECTRIC OPTOGAIT SYSTEM TO MEASURE RACEWALKING BIOMECHANICAL PARAMETERS ON A TREADMILL

Daniel Alvarez[1], Andres Sebastian[2], Laura Pellitero[3], Ventura Ferrer-Roca[1],

[1] Biomechanics Department, CAR Sant Cugat del Valles, Barcelona, Spain
[2] INEFC Barcelona, Barcelona, Spain
[3]ETSEIB, Universitat Politècnica de Catalunya (UPC), Barcelona, Spain

The purpose of this pilot study was to validate the Optogait system to measure racewalking biomechanic parameters on a treadmill. Contact time, flight time, cadence and step length are some of the biomechanic parameters which influence the performance in racewalking. Five subjects were analyzed while racewalking at different speeds on a treadmill. The Optogait system was compared with a high speed video used as reference system. Flight time was overestimated by Optogait when compared with the reference system (0.025 ± 0.014 vs 0.023 ± 0.014 seconds, $t = -2.43$, $p < 0,05$). No differences were found in contact time or step length. Thus, the present study validates the Optogait system to measure racewalking biomechanical parameters on a treadmill.

KEY WORDS: Contact time, flight time, technical analysis, performance.

INTRODUCTION: Racewalking speed depends on the cadence and step length (Hanley, Bissas & Drake, 2014). It has been demonstrated recently that the better athletes perform longer steps (~70% height) at a higher cadence (~200 steps / minute) (Hanley, Bissas & Drake, 2014). When increasing these parameters, the contact time (CT) is reduced and the flight time (FT) increases. However, these changes cannot be unlimited due to the competition rules. Athletes must maintain no visible (to the human eye) loss of contact with the ground, otherwise they can be disqualified. Previous studies have determined that the human eye is able to identify the loss of contact when FT exceeds 40 ms (De Angelis & Menchinelli, 1992). As these parameters are part of the rules and might determine the athlete performance, it was necessary to measure them.
Previous studies have validated the Optogait system for human walking (Lienhard, Schneider & Maffiuletti, 2013) and similar systems for running (Ogueta-Alday, Morante, Rodriguez & Garcia, 2013). However, human walking and racewalking have kinematic differences (Murray, Guten, Mollinger & Gardner, 1983) which may influence the Optogait measurements due to different contact area during heel strike and toe off. Furthermore, Optogait is able to give a real time feedback which might be very useful for technical training. Athletes would be able to perform while knowing contact and flight times in real time so they can modify the technique and see how the biomechanical parameters are affected. This is an advantage over the traditional high-speed camera method where athletes are recorded and the video has to be processed later. This process spends more time and effort and does not give the opportunity to work on the technique in real time. Therefore, it seems necessary to validate the Optogait system to improve racewalking analysis and training.

METHODS: Five 20km racewalk athletes volunteered for the present study (3 men and 2 women; 22.8 ± 4.2 years old; 164.2 ± 9.2 cm height; 56.8 ± 10.1 kg weight). Athletes performed repetitions of 90 seconds at different speeds between 11 and 15 $km \cdot h^{-1}$ on a treadmill (Ergelek EG2). CT and FT were measured during 20 seconds of each repetition using two different systems, the photoelectric Optogait system (OptoGait Microgate SRL, Italy, 2010) and a high speed video (camera Casio Exilim EX-ZR 1000 recording at 1000Hz) (Ogueta-Alday, Morante, Rodriguez & Garcia, 2013). Step length (SL) was measured as well by Optogait and calculated later from the high speed video through the software Kinovea using the CT, FT and treadmill speed. The intraclass correlation coefficient (ICC 2.2) was used to validate the Optogait system compared with the reference system. Furthermore, intra (ICC 3.2) and inter-observer reliability (ICC 2.2) was also checked when analyzing the most relevant speeds (12, 13 and 14 km·h^{-1}). The statistical significance was set at $P<0.05$.

RESULTS: Flight time was overestimated by Optogait when compared with the reference system. However, there were not significant differences in contact time or step length when comparing Optogait with the reference system (Table 1). Optogait demonstrated an excellent concordance with the reference method in the three analyzed parameters (>0.90). In addition, the reference system presented a high reliability intra and inter-observer with values over 0.90 in the three variables (CT, FT and SL).

Table 1. Step length, contact time and flight time means and standard deviations measured by Optogait and the reference system.

	Optogait	Reference System	P value
Step Length (m)	1.055 ± 0.05	1.056 ± 0.05	P>0.05
Contact time (s)	0.271 ± 0.022	0.272 ± 0.022	P>0.05
Flight time (s)	0.025 ± 0.014	0.023 ± 0.014	P<0.05

Furthermore, when the speed was increased the contact time was shorter and the flight time increased as well (Figure 1). These results agree with previous literature (Hanley et al., 2014).

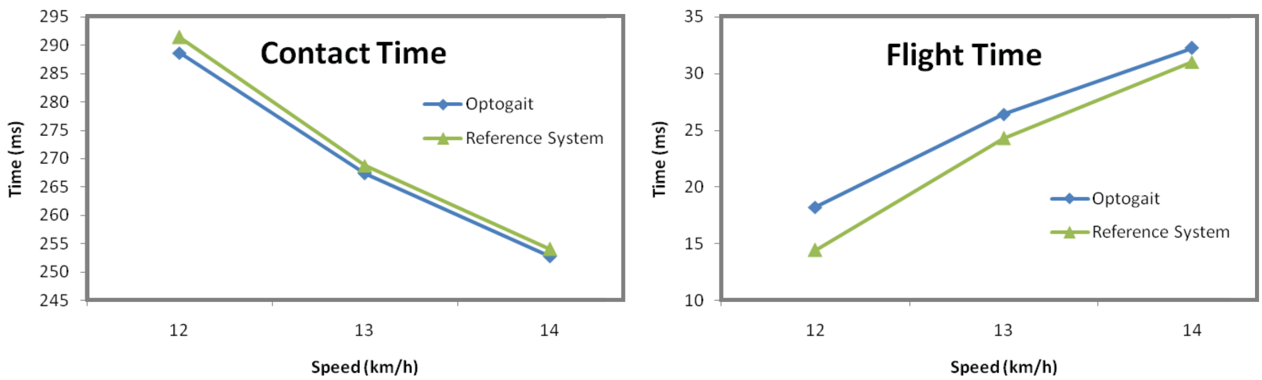

Figure 1. Contact and flight time at different speeds measured by Optogait and the reference system.

DISCUSSION: The Optogait system seems to be a valid system to measure racewalking biomechanical parameters on a treadmill. It is important to emphasize that this validation was done on a specific treadmill where Optogait could be placed at the same level where athletes performed. In case of using a different treadmill where Optogait is placed higher than the walking surface, results would be influenced leading to longer contact times and shorter flight times. Therefore, it is important to remind that the purpose of this pilot study was to know if Optogait is valid to measure biomechanical parameters on a specific treadmill for technical analysis and training.

There was a difference in flight time between Optogait and the reference system. Despite this 2ms difference was statistically significant, the authors do not consider the difference to be relevant on the measure of racewalking variables. As previous studies have demonstrated (De Angelis & Menchinelli, 1992) flight times shorter than 40ms cannot be detected by the human eye and therefore, no penalty can be applied. Thus, a difference of 2ms may not affect the decision of the judges.

According with previous studies (Hanley, Bissas & Drake, 2014), contact time decreased and flight time increased at higher speeds. One of the advantages that Optogait presents is that the results are obtained in real time while the athlete is performing on the treadmill.

Therefore, contact and flight times can be measured while the speed is increased and the changes can be observed immediately. This real time feedback is one of the most important benefits of Optogait for technical training.
Furthermore, as the measurement is done on a treadmill, a large number of steps can be recorded without altering athlete’s motion using only two meters of Optogait. Otherwise, a longer Optogait would be needed as well as more time in order to get the athlete through it. This would lead on a more expensive system and longer measurement sessions. Information of right and left sides is obtained separately, so asymmetries can be detected as well.
All the information above proves the importance of the present study and how beneficial can it be to the athletes in terms of technical training and performance enhancing.

CONCLUSION: The present study validates the photoelectric system Optogait as a new method to analyze racewalking biomechanical parameters. The new method may have an important application to the technical training allowing real time feedback of parameters such as contact time, flight time and step length.

REFERENCES:

Ogueta-Alday, A., Morante, J.C., Rodríguez-Marroyo, J.A. & García-López, J. (2013). Validation of a new method to measure contact and flight times during treadmill running. J *Strenght Cond Res*, *27*(5), 1455–1462.

Hanley, B., Bissas, A. & Drake, A. (2014). Technical characteristics of elite junior men and women race walkers. *J Sports Med Phys Fitness*, 54 (6): 700-7

De Angelis, M., & Menchinelli, C. (1992). Time of flight, frequency and length of stride in walking. *ISBS-Conference Proceedings Archive* (Vol. 1, No. 1).

Hanley, B., Bissas, A., & Drake, A. (2011). Kinematic characteristics of elite men's and women's 20 km race walking and their variation during the race. *Sports Biomechanics*, *10*(02), 110-124.

Lienhard, K., Schneider, D., & Maffiuletti, N. A. (2013). Validity of the Optogait photoelectric system for the assessment of spatiotemporal gait parameters. *Medical Engineering and Physics*, *35*(4), 500–504.

Murray, M. P., Guten, G. N., Mollinger, L. A., & Gardner, G. M. (1983). Kinematic and electromyographic patterns of Olympic race walkers. *The American journal of sports medicine*, *11*(2), 68-74.