pISSN 1598-298X / eISSN 2384-0749
J Vet Clin 36(6) : 297-300 (2019)
http://dx.doi.org/10.17555/jvc.2019.12.36.6.297

Journal of Veterinary Clinics
www.ksvc.or.kr

Validity of the Wii Balance Board for Evaluation of Medial Patellar Luxation in Small Sized Dog

Shinho Lee, Joo-Myoung Lee, Hyunjung Park, Yuri Cha* and Jongtae Cheong[1]

Department of Veterinary Medicine, College of Veterinary Medicine, Jeju National University, Jeju 63243, Korea
**Department of Physical Therapy, College of Sunlin, Pohang 37560, Korea*

(Received: October 08, 2019 / Accepted: November 20, 2019)

Abstract : Wii® balance board (WBB) is a device that can measure and record body sway. This study was conducted to evaluate the reliability of WBB in small sized dog as inexpensive, portable and convenient tool. The center of pressure path length (CPPL) and 95% confidence ellipse area (Area 95) were evaluated with only two plates of WBB. The parameters were evaluated between no load (0 kg) and mass group (0.25-4 kg on each one plate). 23 dogs (2.3-7.3 kg) were evaluated for with hindlimb standing for 10 seconds. The mass group showed a significant value in comparison to the no load during the measurement. And intra-class correlation coefficients (ICCs) between CPPL and Area 95 revealed very high both mass and dog group. In the evaluation of medial patellar luxation (MPL) as a diagnostic tool, 80 dogs with MPL and 23 non-affected dogs were used. In studies of CPPL and Area 95, significant differences were found between non-affected and MPL groups for 10 and 30 seconds, respectively. The WBB can be used as a valid tool for evaluating hind limb standing balance and can be useful as an objective tool to present clinical results in small sized dog with MPL.

***Key words* :** Wii balance board (WBB), body sway, center of pressure path length (CPPL), 95% confidence ellipse area (Area 95), dog.

Introduction

Body sway is defined as constant compensatory movements. The continuous movement of the body's center of mass can be measured through detecting fluctuations of the center of pressure (COP) (2,13). The center of pressure path length (CPPL) is a sum of distance in the location where all the vertical force acts (16). Area 95 means 95% confidence ellipse area (3). CPPL and Area 95 have been shown to be effective parameters to monitor body sway (10). Static standing COP measures may be used as a good reliability and validity for assessment of static standing balance and weight-bearing asymmetry in human adults for the analysis of postural control sway (4,5).

The WBB has generated the significant interest in the human neurorehabilitation research domain and the system is relatively inexpensive, easy to access and portable (8). A few studies have used custom software to interface a computer to the WBB to measure CPPL and Area 95 (5,16).

It has been reported that medial patellar luxation (MPL) increases the stress on the musculoskeletal system, predisposing the structure to deformity of stifle joint and cranial cruciate ligament rupture. Secondary osteoarthritis (OA) is a common result of MPL (1,15).

Since there is not enough information on the benefits of the reliability and validity of parameters using WBB in the application of small animals, it is necessary to evaluate the suitability of the device for measuring the body sway.

The purpose of this study was to provide the basic data for static loads provided with calibrated data to allow researchers to evaluate CPPL and Area 95. And this study is to verify that WBB can be used as a valid tool for diagnosing MPL.

Materials and Methods

Study design

For testing WBB, no load (0 kg) and 16 separate masses ranging of 0.25-40 kg were tested. It was assessed by adding 0.25 kg from 0 g to 4 kg. Each mass was centered and data were collected from only two plate channels via the customized software (Balancia® v2.0, Minto systems, Korea) at 100 Hz three times for 10 seconds.

A total of 23 intact dogs were included (2.3-7.3 kg) with quiet hindlimb standing. The dogs were positioned with an angle of 30-40 degrees. The angle was determined by the horizontal plane and the line joining the dorsal aspect of scapular spine and greater trochanter. Dogs were performed three repetitions in hindlimb standing on the WBB for 10 seconds.

A total of 103 dogs were examined. 80 dogs with MPL were diagnosed in animal hospital after orthopedic and radiological examinations. 23 dogs were non-affected. Some of the patients were asymptomatic, and some had various degrees of unilateral or bilateral lameness, sometimes difficulty and reluctance to walk, jump and go upstairs. If the dog with bilateral MPL had the same grade, only one side as same

[1]Corresponding author.
E-mail : cjt123@jejunu.ac.kr

grade was included in this study. If the dog with MPL had different grade, the only higher grade was included.

Statistical analysis

All statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS Inc. Version 19.0, Chicago, IL, USA). The three repetitions of each testing condition were used to describe relative reliability. Data was presented as means ± SD. Differences were seemed to be statistically significant when $p < 0.05$. An intraclass correlation coefficient (ICC) between 0.75 and 1 was considered high, 0.4-0.74 modest and less than 0.39 low (Clark *et al.*, 2010).

Results

The each average of CPPL and Area 95 was 13.4 ± 0.77 m, 22.6 ± 7.55 cm^2 in no load. A statistical significance in CPPL and Area 95 was found between no load and mass group ($p < 0.01$) (Table 1). ICC (= 0.91) value was shown to be consistently excellent between CPPL and Area 95 from scatter plots (Fig 1A). The each average of CPPL and Area 95 was 2.9 ± 0.81 m, 2.0 ± 0.71 cm^2. ICC value (= 0.86) were found to be statistically significant in 23 intact small sized dogs (Fig 1B).

A total of 103 small sized dogs were used in this study. 80 with MPL and 23 non-affected dogs were included in the proposed protocol. The each average CPPL and Area 95

Table 1. Comparison of CPPL and Area 95 between no load and mass groups

Mass	Number	CPPL (m)	Area 95 (cm^2)
0 g	3	13.4 ± 0.77	22.6 ± 7.60
250 g	3	8.1 ± 1.06**	13.6 ± 10.39**
500 g	3	5.5 ± 0.18**	4.0 ± 0.12**
750 g	3	4.2 ± 0.12**	2.4 ± 0.14**
1000 g	3	2.5 ± 0.12**	0.9 ± 0.10**
1250 g	3	2.3 ± 0.04**	0.8 ± 0.19**
1500 g	3	2.1 ± 0.01**	0.6 ± 0.02**
1750 g	3	1.9 ± 0.04**	0.5 ± 0.04**
2000 g	3	1.8 ± 0.02**	0.4 ± 0.02**
2250 g	3	1.5 ± 0.01**	0.3 ± 0.01**
2500 g	3	1.3 ± 0.04**	0.3 ± 0.01**
2750 g	3	1.3 ± 0.05**	0.2 ± 0.00**
3000 g	3	1.1 ± 0.04**	0.2 ± 0.00**
3250 g	3	1.1 ± 0.03**	0.2 ± 0.00**
3500 g	3	1.1 ± 0.08**	0.2 ± 0.00**
3750 g	3	1.0 ± 0.03**	0.1 ± 0.00**
4000 g	3	0.9 ± 0.01**	0.1 ± 0.00**

Variable: Mean ± SD, **: $p < 0.01$.

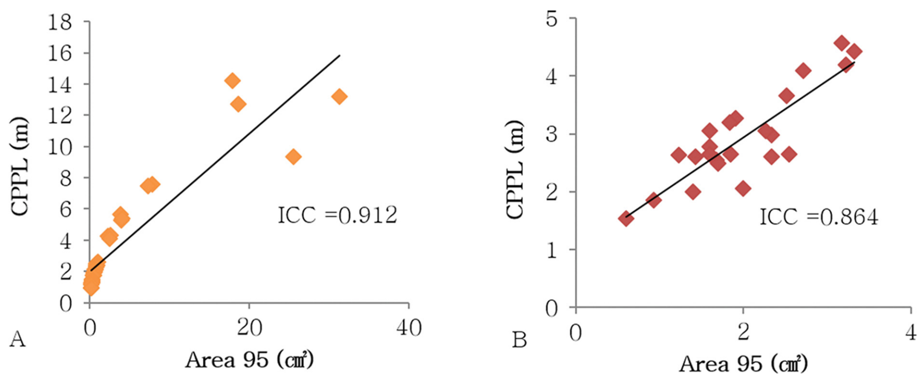

Fig 1. Scatter plot illustrating the relationship between CPPL and Area 95. (A) The reliability of outcome measure was shown very high in no load and mass group. (B) The reliability of outcome measure was shown very high in dogs group.

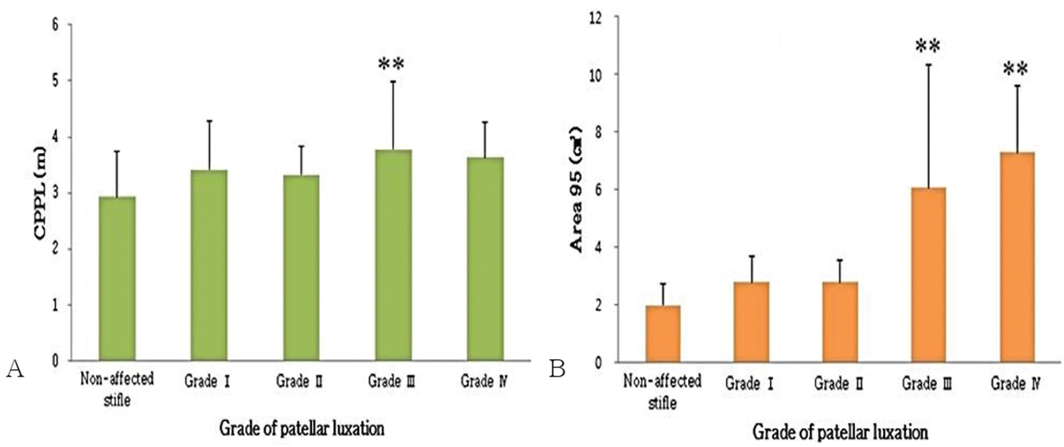

Fig 2. Comparison of the CPPL and Area 95 between non-affected stifle and MPL group for 10 seconds. (A) The graph was shown significant results on grade IV in the CPPL. (B) The graph was shown significant on grade III and IV. ** $p < 0.01$.

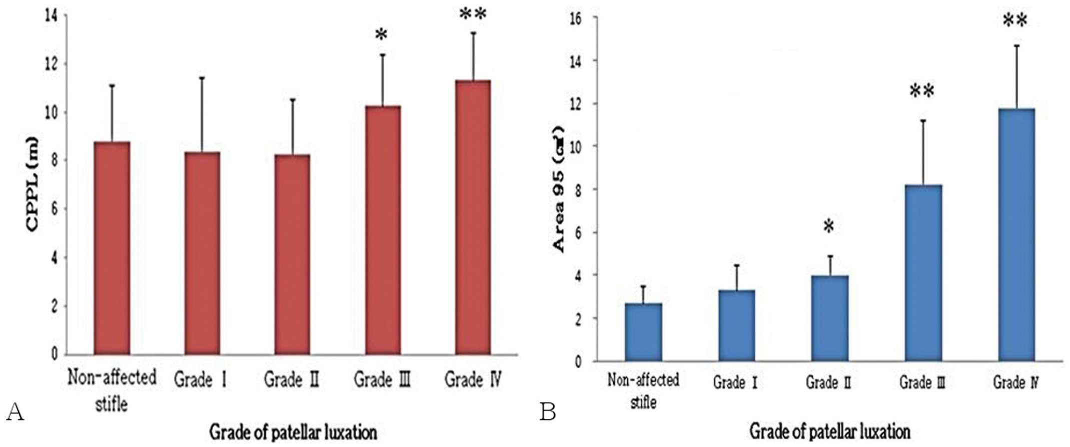

Fig 3. Comparison of the CPPL and Area 95 between non-affected stifle and MPL group for 30 seconds. (A) The graph was shown significant results on grade III, IV in the CPPL. (B) The graph was shown significant on grade II, III and IV. * $p < 0.05$, ** $p < 0.01$.

during 10 seconds were 2.9 ± 0.81 m, 2.06 ± 0.77 cm^2 in non-affected dogs. CPPL was 3.4 ± 0.86 m in grade I group, 3.4 ± 0.50 m in grade II group, 3.8 ± 1.20 m in grade III group, and 3.6 ± 0.63 m in grade IV group. The difference between non-affected group and grade III group was highly significant in CPPL ($p < 0.01$) (Fig 2A). The Area 95 in grade I was 2.8 ± 0.90 cm^2, 2.7 ± 0.70 cm^2 in grade II group, 6.1 ± 4.26 cm^2 in grade III group, and 7.3 ± 2.34 cm^2 in grade IV group. The differences among non-affected group and grade III, IV groups were highly significant in Area 95 ($p < 0.01$) (Fig 2B).

The average CPPL and Area 95 during 30 seconds were 8.8 ± 2.34 m, 2.6 ± 0.76 cm^2 in non-affected dogs, respectively. CPPL was 8.4 ± 3.02 m in grade I group, 8.3 ± 2.20 m in grade II group, 10.3 ± 2.12 m in grade III group, and 11.3 ± 1.97 m in grade IV group. The differences among non-affected and grade III, IV group were significant ($p < 0.05$ and $p < 0.01$, respectively) (Fig 3A). Area 95 was 3.3 ± 1.16 cm^2 in grade I, 4.0 ± 0.84 cm^2 in grade II group, 8.2 ± 2.99 cm^2 in grade III group, and 11.8 ± 2.86 cm^2 in grade IV group. The differences among non-affected group and grade II, III and IV groups were highly significant in Area 95 ($p < 0.05$, $p < 0.01$ and $p < 0.01$, respectively) (Fig 3B).

Discussion

In dogs with hindlimb OA, bathroom scale can be used as reliable, objective method by measuring of symmetry of the static weight bearing (11). With this similarity in WBB, the CPPL and Area 95 can also be deviated as a trajectory according to its displacement during hindlimb standing. Using WBB was able to measure the distance and area of weight shift and sample them conveniently rather than using a scale.

The center of mass in dog is closer to the forelimbs during standing. For this reason, the center of mass contributes to this imbalance in hindlimb to forelimb weight distribution when standing (7,14). This study was carried out by selecting two of the four plates on the WBB to load weight on the forelimb or hindlimb in small animals. In order to clarify the orthopedic problems of quadruped animals, this study was designed to allow the load to be concentrated in the only two hindlimbs. Considering this is the actual load proportional to the weight bearing of the dog affecting the critical results, only two load cells are used in this study.

Stairs had significant difference with peak vertical force, impulse in method of physiotherapeutic evaluation as outcome measures of stifle functionality in dogs (12). The dog's forelimbs were picked up on the table slightly and made standing position as dog climbing the stairs to gain more information on the abnormal body way. The position was made the dog as much weight loading on his hindlimb as possible. In clinical experience, using four plates (each limb on the WBB) was in practice difficult and non-rewarding. Because there are so many distracted dogs, they could not be controlled on the WBB. Nevertheless, two plates that measure only the difference between less-affected and affected stifles were specific enough to recognize static weight shift, and it could be reliably used as an outcome measure.

In previous study, use of bathroom scales in measuring asymmetry of hindlimb static weight bearing in dogs with OA in at least one stifle joint, with or without hip joint OA showed reliability and objectivity (11). This study also showed that static evaluation of hindlimb might be differentiated from problematic limb. This study showed significance due to the instability of the joint with extended stifle joint, which the patellar tendon is deflected medially and the proximal tibia is changed biomechanically. WBB can provide data for static standing using computerized posturography in this study. The trajectory of COP in static weight shift between the hindlimbs can be evaluated visually to higher MPL grade especially.

While many big sized dogs with grade I MPL group encounter clinical symptoms, small dogs are never affected (9). In this study, the CPPL and Area 95 in gradeI was no significant difference despite the increase in evaluation time. This means that grade I MPL group is not enough to affect the body sway on the WBB in small sized dog.

Previous study using medical infrared imaging in the thermal pattern of the paw print in the lame hindlimb compared to a non-lame hindlimb concluded that asymmetry index analysis revealed 5% in the healthy group and 36.2% in the lame group in a standing position for 30 seconds (6). In this study, grade III and IV groups were significantly different from grade I and II groups, suggesting that distance of trajectory point was significantly increased for 30 seconds. Area 95 were greater in grade II, III and IV groups as observed in this study, which sway area is greater and this may be any possible compensation to avoid mechanical stress by shifting one sided weight loading towards less-affected side.

In conclusion, the portable and economical WBB demonstrated to have good validity and reliability. This study showed that evaluation for 30 seconds with static hindlimb standing is an objective, diagnostic tool in small sized dog with high grade MPL.

Acknowledgements

This work was supported by the 2019 education, research and student guidance grant funded by Jeju National University.

References

1. Alam MR, Ji JR, Kim MS, Kim NS. Biomarkers for identifying the early phases of osteoarthritis secondary to medial patellar luxation in dogs. J Vet Sci 2011; 12: 273-280.
2. Bekkers EM, Dockx K, Heremans E, Vercruysse S, Verschueren SM, Mirelman A, Nieuwboer A. The contribution of proprioceptive information to postural control in elderly and patients with Parkinson's disease with a history of falls. Front Hum Neurosci 2014; 8: 939.
3. Brichetto G, Spallarossa P, de Carvalho ML, Battaglia MA. The effect of Nintendo Wii on balance in people with multiple sclerosis: a pilot randomized control study. Mult Scler 2013; 19: 1219-1221.
4. Clark RA, Bryant AL, Pua Y, McCrory P, Bennell K, Hunt M. Validity and reliability of the Nintendo Wii Balance Board for assessment of standing balance. Gait Posture 2010; 31: 307-310.
5. Clark RA, McGough R, Paterson K. Reliability of an inexpensive and portable dynamic weight bearing asymmetry assessment system incorporating dual Nintendo Wii Balance Boards. Gait & Posture 2011; 34: 288-291.
6. Garcia EFV, Loughin CA, Marino DJ, Sackman J, Umbaugh SE, Fu J, Schossler JEW. Medical infrared imaging and orthostatic analysis to determine lameness in the pelvic limbs of dogs. Open Vet J 2017; 7: 342-348.
7. Gillette RL, Graig T. Recent developments in canine locomotor analysis: a review. Vet J 2008; 178: 165-76.
8. Goble DJ, Cone BL, Fling BW. Using the Wii Fit as a tool for balance assessment and neurorehabilitation: the first half decade of "Wii-search". J Neuroeng Rehabil 2014; 11: 12.
9. Harasen G. Patellar luxation. Can Vet J 2006a; 47: 817-818.
10. Harris GF, Riedel SA, Matesi D, Smith P. Standing postural stability assessment and signal stationarity in children with cerebral palsy. IEEE Trans Rehabilitation Eng 1993; 1: 35-42.
11. Hyytiainen HK, Molsa SH, Junnila JT, Laitinen-Vapaavuori OM, Hielm-Bjorkman AK. Use of bathroom scales in measuring asymmetry of hindlimb static weight bearing in dogs with osteoarthritis. Vet Comp Orthop Traumatol 2012; 25: 390-396.
12. Hyytiainen HK, Molsa SH, Junnila JT, Laitinen-Vapaavuori OM, Hielm-Bjorkman AK. Ranking of physiotherapeutic evaluation methods as outcome measures of stifle functionality in dogs. Acta Vet Scand 2013; 55: 29.
13. Manera ME, Carrillo JM, Batista M, Rubio M, Sopena J, Santana A, Vilar JM. Static posturography: A new perspective in the assessment of lameness in a canine model. PLoS One 2017; 12: e0170692.
14. Moreau M, Lussier B, Ballaz L, Troncy E. Kinetic measurements of gait for osteoarthritis research in dogs and cats. Can Vet J 2014; 55: 1057-1065.
15. Mortari AC, Rahal SC, Vulcano LC, da Silva VC, Volpi RS. Use of radiographic measurements in the evaluation of dogs with medial patellar luxation. Can Vet J 2009; 50: 1064-1068.
16. Park DS, Lee G. Validity and reliability of balance assessment software using the Nintendo Wii balance board: usability and validation. J Neuroeng Rehabil 2014; 11: 99.