Use of bathroom scales in measuring asymmetry of hindlimb static weight bearing in dogs with osteoarthritis

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Weight bearing, bathroom scale, osteoarthritis, physiotherapy, outcome measure

Summary
Objective: The study assessed the use and reliability of bathroom scales as an objective measurement tool, and setting a normal variance of static weight bearing between hindlimbs.

Methods: Two groups of dogs were tested: a healthy control group (n = 21) and a group (n = 43) of dogs with confirmed osteoarthritis in at least one stifle joint, with or without hip joint osteoarthritis. Static weight bearing was evaluated manually and measured with two bathroom scales. An orthopaedic examination was done and dynamic weight bearing was measured using a force platform. Radiographs were taken to confirm the presence of osteoarthritis, and dogs were divided into groups of severe and non-severe osteoarthritic changes. Reliability by repeatability was tested using analysis of variance, and the congruity between static weight bearing and other evaluation methods with Kappa statistics and proportion of agreement.

Results: The difference between the hindlimbs proportional to the body weight in control dogs was 3.3% (± 2.7%). The repeatability of measuring static weight bearing in the hindlimbs of osteoarthritic dogs with bathroom scales was 81% with osteoarthritic limbs, and 70% for unaffected limbs. The sensitivity of static weight bearing measurements using bathroom scales was 39% and specificity 85%.

Clinical significance: Bathroom scales are a reliable, simple, and cost-effective objective method for measuring static weight bearing and can be used as an outcome measure when rehabilitating dogs with osteoarthritic changes in the hindlimbs.

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Introduction
The need for objective outcome measures in veterinary physiotherapy and orthopaedics is flagrant (1–3). An easy to use mechanism to determine if the function is back to normal would be an excellent tool both for surgeons and physiotherapists. To be useful, outcome measures must be proven valid and reliable. This is done by various statistical methods, depending on the study design (4–5).

Static weight bearing evaluates the weight bearing of limbs during standing, whereas dynamic weight bearing is evaluated during walking or running. Both are important for evaluating physiotherapeutic and orthopaedic canine patients (6–7). Force platforms and pressure-sensitive walkways are now commonly used in research, providing quantitative data on dynamic weight bearing (8–10). Some models also measure static weight bearing. Force platforms are considered the gold standard of objective lameness examination, but are expensive and time-consuming to use in clinical work. A computerized static quadruped load distribution device has been used to measure canine static weight bearing and the effect of the surroundings on the weight bearing between limbs. In a recent study, weighing platforms were used to measure static weight bearing in dairy cows (11). Changes in static weight distribution between limbs measured with automated platforms are a good method for detecting lameness and assessing the level of analgesia in cows. Functional recovery after total stifle joint transplantation in dogs was also evaluated with industrial scales connected to a computer, thus automating the measurements (12).

The use of bathroom scales as a measurement device for static weight bearing has been reported, although more widely in humans than in animals (13–17). They are readily available and could therefore be an economical objective measurement method if proven reliable and valid in dogs. The accuracy and reliability of scales as a human measurement tool are favourable (15). Animal studies have not address-
ed the validity or the reliability of bathroom scales as a measurement tool. However, the static weight bearing measured with bathroom scales was used as a measurement tool in evaluating the healing of canine tibial osteotomies under external fixation, and the changes were measurable (16). The study pointed out the value of static weight bearing as a method of measuring functionality. Not only was there a change in static weight bearing recorded during the healing process, but also the difference in the static weight bearing during the healing process between two different surgical methods was seen. In another study that evaluated weight bearing during healing of the canine tibia cortex, the changes were also measurable using bathroom scales (17).

Cranial cruciate ligament deficiency is one of the most common orthopaedic hindlimb problems in dogs (18). Cranial cruciate ligament deficiency with stifle joint instability results in development of osteoarthritis (OA), and in most dogs these changes progress even after surgical repair of the cranial cruciate ligament deficiency (19, 20). One of the most common signs of OA in dogs is lameness and muscle atrophy, indicating that dogs probably bear less weight on the limb with OA. Although several studies evaluating dynamic weight bearing exist, no studies evaluating static weight bearing in dogs with OA have been published (9, 10, 21).

Our aim was to provide veterinarians and physiotherapists working with canine stifle OA with an easy and reliable tool and guidelines on how to measure canine hindlimb static weight bearing. The present study was performed to conduct reliability testing of a quantitative measurement of hindlimb static weight bearing using bathroom scales. We hypothesized that bathroom scales are a reliable and valid tool for measuring static weight bearing in dogs with OA in the hindlimbs.

Materials and methods

Animals

A control group of 21 healthy dogs with no known musculoskeletal problems, and a group of 43 dogs that had been surgically treated due to unilateral partial or complete cranial cruciate ligament rupture over one year previously were enrolled in the study (21). Various surgical techniques were used with these dogs. In all dogs the cruciate ligament rupture was confirmed by arthroscopy. Surgically treated, cranial cruciate ligament deficient dogs were used because OA changes were expected in the affected stifle joint. Inclusion criteria included unilateral stifle OA with or without hip joint OA. All dogs were privately owned and were part of a long-term follow-up study that will be reported elsewhere. Consent from owners was obtained and the study was approved by the University of Helsinki Ethical Review Board at the Viikki Campus.

In the control group there were 12 Labrador Retrievers and nine Rottweilers, seven of which were males and 14 females. The mean ± standard deviation (SD) age and body weight of the dogs were 38.5 ± 19.4 months and 35.5 ± 8.3 kg, respectively. The dogs did not have any known orthopaedic problems or abnormal findings on the orthopaedic examination, and radiographic screening results free of hip dysplasia according to the Federation Cynologique Internationale screening protocol (grade A or B) were used.

In the OA group, there were 15 Labrador Retrievers, six Rottweilers, three Golden Retrievers, three mixed breed dogs, two Bernese Mountain Dogs, two Newfoundland Dogs, two Nova Scotia Duck Tolling Retrievers, and one each of the following: Black Russian Terrier, Bordeaux Dog, Bullmastiff, Collie, Dalmatian Dog, Doberman Pinscher, Giant Schnauzer, Karelian Bear Dog, Pointer, and Short-Haired German Pointer. Nineteen of the dogs were males and 24 were females. The mean ± SD age of the dogs was 83.8 ± 30.2 months and the mean ± SD body weight was 37.6 ± 9.4 kg.

The following examinations were done: manual static weight bearing evaluation, quantitative static weight bearing measurement with bathroom scales, orthopaedic examination, dynamic force platform evaluation, and radiographic examination. Based on the last three, a conclusive assessment was made. All static weight bearing measurements were performed by the same examiner (HH). Orthopaedic examinations, force platform examinations, and the conclusive assessment were performed by one examiner (SM). The radiographs were evaluated by two examiners (OL-V, AH-B).

Manual evaluation of static weight bearing: distribution between hindlimbs

The owner held the dog from the front in a straight, square standing position, and was instructed not to provide any manual support for the dog. The examiner, kneeling behind the dog, lifted up each hindlimb in turn, holding both limbs around the metatarsal area. The limbs were lifted up three to 10 times each, until a decision on the symmetry of static weight bearing between the limbs was made. The resistance and weight bearing of each limb were evaluated and the dogs were classified as follows: 1 = symmetrical or bearing less weight on either the 2 = left or 3 = right hindlimb. It was not possible to differentiate whether the dog had normal or decreased static weight bearing bilaterally.

Quantitative measurement of static weight bearing: distribution between hindlimbs

Two identical, factory calibrated, commercially available digital bathroom scalesb were used, individually, under each hindlimb. The forelimbs were placed on a custom-made, non-slippery platform of the same height as the scales. The scales gave a stationary final value with a measurement accuracy of 0.1 kg over a measurement range from 3 kg to 150 kg. As the scales were factory calibrated, no manual calibration was done. The owner of the dog held the dog from the front, keeping it in a straight, square-standing position, and was instructed not to provide any manual support for the dog. The examiner kneeled behind the dog and placed the hindlimbs symmetrically onto the scales, and recorded measurements for both limbs. Four measurements were recorded, with the dog

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b Medica plus M-135: Truebell, Vantaa, Finland
either stepping off from the scales between measurements, or, in case of behavioural problems, with the examiner lifting the hindlimbs into the air while the scales were reset. The dog stood on the scales until a stationary final value was obtained. The mean values were calculated for each dog and were later used in the statistical analyses.

Orthopaedic examination

A complete orthopaedic examination, including lameness evaluation on a scale from 0 to 4 (where 0 = no lameness and 4 = non-weight-bearing lameness), palpation of the limbs and spine for pain, crepitation, swelling, decreased range-of-motion, and instability, as well as evaluation of conscious proprioception and withdrawal reflex was performed (22). Based on the findings, the dogs were grouped as 1 = no findings in hindlimbs, findings in either the 2 = left or 3 = right hindlimb, or 4 = bilaterally abnormal.

Dynamic force platform evaluation

The gait analysis was performed during a force platform4 analysis, using the same setup as described elsewhere (21). The signal from the platform was processed and stored, using a computer-based software program3, and velocities and acceleration were determined by three photoelectric cells placed 1 m apart and a start-interrupt timer system4. The dogs were guided over the force platform at a trotting velocity of 2.10–2.50 m/s and acceleration of –0.5 to +0.5 m/s². Five valid runs for left and right limbs were selected and the means of body weight-corrected peak vertical force (PVF) and impulse (IMP) were calculated. The dogs were classified as 1 = hindlimbs symmetrical or applying less force on either the 2 = left or 3 = right hindlimb, if the difference between limbs was greater than the mean differences ± SD.

Radiographic examination

Mediolateral and craniocaudal radiographs of both stifles and extended ventrodorsal radiographs from the hip joints bilaterally were taken of OA dogs under sedation. No radiographs were taken of the control group dogs. The radiographs were graded according to the OA findings on a scale from 0 to 3, where 0 = no OA findings, 1 = mild OA findings, 2 = moderate OA findings, and 3 = severe OA findings (23, 24). Based on the stifle and hip radiographs, the dogs were classified as 1 = bilaterally no OA findings in either the stifle or hip joint, or having radiological OA findings in either the 2 = left or 3 = right stifle or hip joint, or 4 = bilaterally.

Conclusive assessment

Finally, the conclusive assessment consisted of a veterinary surgeon’s subjective final clinical assessment, based on all data available: signs of lameness and abnormalities from the orthopaedic examination, OA changes in the stifle and hip joints from radiographic examination, and hindlimb asymmetry from peak vertical forces and vertical impulses data in force platform analysis. All these were evaluated together in order to classify the hindlimb as 1 = no findings in the hindlimbs, findings in either the 2 = left or 3 = right hindlimb, or 4 = bilaterally.

Statistical methods

The repeatability of the bathroom scale measurements was calculated using a oneway analysis of variance model in which the dog was used as a sole explanatory factor. The intra- and intergroup mean squares were used to calculate an estimate of the repeatability of the measurement.

Since the dogs were of different breeds and sizes, the means of the static weight bearing measurements were converted from kilograms to percentages proportional to the total weight, and the results were handled as such. The mean difference (± SD) in static weight bearing between the hindlimbs proportional to the body weight in the control dogs was 3.3% (± 2.7%). Based on the normal-limit of six percent (3.3% ± SD 2.7%), the results of the OA dog static weight bearing were interpreted as 1 = symmetrical weight bearing if the difference in static weight bearing was less than six percent, 2 = decreased weight bearing in the left hindlimb, or 3 = decreased weight bearing in the right hindlimb.

In order to allow comparison between levels of OA, the dogs were further categorised into two groups where mild (= 1) and moderate (= 2) radiological OA changes were classified as not-severe, and severe (= 3) stayed as severe.

The congruity between the static weight bearing based on bathroom scales and the various evaluation methods was examined by calculating pair-wise proportions of agreement and their 95% confidence intervals for the various methods and results separately for each outcome class and OA severity classification. The overall congruity between the methods was assessed with Cohen’s Kappa coefficient.

When the agreement and Kappa were evaluated, a range of less than zero was considered to have less than chance agreement, 0.01–0.20 to have slight agreement, 0.21–0.40 fair agreement, 0.41–0.60 moderate agreement, 0.61–0.80 substantial agreement, and 0.81–0.99 almost perfect agreement (25). All statistical analyses were done with the SAS System for Windows, version 9.2.

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3 Kistler Type 9286: Kistler Instrumente AG, Winterthur, Switzerland
4 Aquire 7.3: Sharon Software Inc., DeWitt, Michigan, USA
5 SAS Institute Inc., Cary, NC, USA
Results

All dogs in the surgically treated cranial cruciate ligament deficiency group were confirmed to have at least grade 1 OA changes in one or more of either the stifle or hip joint. There were three dogs in the OA group in which force platform analysis was not performed due to lack of cooperativeness or poor physical condition. Manual weight-bearing evaluation was not performed for two control and five OA dogs because one was overactive while the others were timid of the situation or of being handled by a stranger. Bathroom scale measurements were not taken for two OA dogs due to the same behavioural problem.

Reliability

With the set limit for normal difference in static weight bearing (3.3% ± 2.7%), the sensitivity of static weight bearing measurements using bathroom scales was 39% and specificity 85%. The repeatability of the static weight bearing measurements was 76% for all dogs, 61% for control group dogs, and 79% for OA dogs. The overall repeatability was 66% in the right, and 56% in the left hindlimb of the control dogs.

Table 1

<table>
<thead>
<tr>
<th>Evaluation method used</th>
<th>Hindlimb status grouping</th>
<th>n</th>
<th>Severe osteoarthritis (n = 22)</th>
<th>Non-severe osteoarthritis (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Proportion of agreement</td>
<td>Lower 95% CI</td>
</tr>
<tr>
<td>Manual evaluation of static weight bearing (n = 38)</td>
<td>Symmetrical</td>
<td>13</td>
<td>36%</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
<td>33%</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>15</td>
<td>57%</td>
<td>0.18</td>
</tr>
<tr>
<td>Orthopedic examination by veterinary surgeon (n = 43)</td>
<td>1</td>
<td>0</td>
<td>0%</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>18</td>
<td>56%</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>9</td>
<td>68%</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>16</td>
<td>47%</td>
<td>0.24</td>
</tr>
<tr>
<td>Force platform PVF (n = 40)</td>
<td>Symmetrical</td>
<td>20</td>
<td>46%</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>11</td>
<td>29%</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>9</td>
<td>60%</td>
<td>0.15</td>
</tr>
<tr>
<td>Force platform IMP (n = 40)</td>
<td>Symmetrical</td>
<td>23</td>
<td>62%</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>11</td>
<td>33%</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>6</td>
<td>75%</td>
<td>0.19</td>
</tr>
<tr>
<td>Stifle radiographs (n = 42)</td>
<td>1</td>
<td>1</td>
<td>0%</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>19</td>
<td>50%</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>11</td>
<td>38%</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>11</td>
<td>47%</td>
<td>0.24</td>
</tr>
<tr>
<td>Hip + Stifle radiographs (n = 42)</td>
<td>1</td>
<td>1</td>
<td>0%</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>24</td>
<td>46%</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>12</td>
<td>38%</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>5</td>
<td>47%</td>
<td>0.24</td>
</tr>
<tr>
<td>Conclusive assessment (n = 40)</td>
<td>1</td>
<td>0</td>
<td>0%</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>17</td>
<td>63%</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>9</td>
<td>60%</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>14</td>
<td>44%</td>
<td>0.22</td>
</tr>
</tbody>
</table>

Key: n = number; 95% CI = 95% confidence interval; PVF = peak vertical force; IMP = impulse.
Table 2: Overall congruity by Kappa (K) statistics and 95% confidence intervals (CI) for bathroom scales versus other measures in osteoarthritis (OA) dogs (n = 43). Dogs were categorised into two groups where mild (=1) and moderate (=2) radiological OA changes were classified as not-severe, and severe (=3) as severe.

<table>
<thead>
<tr>
<th>Measure versus bathroom scales</th>
<th>Severe osteoarthritis (n = 22)</th>
<th>Non-severe osteoarthritis (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>95% CI</td>
<td>K</td>
</tr>
<tr>
<td>Manual</td>
<td>0.38</td>
<td>0.03</td>
</tr>
<tr>
<td>Orthopaedic</td>
<td>0.30</td>
<td>0.10</td>
</tr>
<tr>
<td>Conclusive assessment</td>
<td>0.26</td>
<td>0.06</td>
</tr>
<tr>
<td>Peak vertical force</td>
<td>0.38</td>
<td>-0.01</td>
</tr>
<tr>
<td>Impulse</td>
<td>0.52</td>
<td>0.16</td>
</tr>
<tr>
<td>Stifle radiographs</td>
<td>0.23</td>
<td>0.04</td>
</tr>
<tr>
<td>Hip + stifle radiographs</td>
<td>0.23</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Table 3: Accuracy of manual evaluation of static weight bearing between hindlimbs.

<table>
<thead>
<tr>
<th>Difference of static weight bearing in hindlimbs</th>
<th>Accuracy of manual evaluation in percentiles</th>
<th>Difference of static weight bearing in hindlimbs in percentiles</th>
<th>Accuracy of manual evaluation in percentiles.</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;4 kg</td>
<td>87.5%</td>
<td>&gt;25%</td>
<td>88.9%</td>
</tr>
<tr>
<td>&gt;3 kg</td>
<td>84.6%</td>
<td>&gt;20%</td>
<td>85.7%</td>
</tr>
<tr>
<td>&gt;2 kg</td>
<td>82.4%</td>
<td>&gt;15%</td>
<td>73.7%</td>
</tr>
<tr>
<td>&gt;1 kg</td>
<td>59.4%</td>
<td>&gt;10%</td>
<td>64.0%</td>
</tr>
<tr>
<td>&gt;0.5 kg</td>
<td>57.5%</td>
<td>&gt; 5%</td>
<td>59.5%</td>
</tr>
</tbody>
</table>

According to the conclusive assessment of OA dogs, the repeatability of the measurement was 74% and 83% for dogs with unilateral and bilateral hindlimb findings, respectively. Furthermore, with the OA dogs, the repeatability was 81% with the affected and 70% with the unaffected limbs.

Agreement

When we compared the bathroom scale measurement and the manual evaluation of static weight bearing, on average the agreement was 42% for the severe OA group, and 58% for the not-severe group (Table 1). With manual evaluation of static weight bearing, differences of over five percent or 1 kg between the hindlimbs in weight bearing could only be detected with 59.5% and 59.4% accuracies, respectively (Table 3). The Kappa values between bathroom scale static weight bearing and force platform analysis within the severe and the not-severe OA group were as follows: 0.52 and 0.12 between static weight bearing and the force plate impulse IMP, indicating a moderate and slight agreement, and 0.38 and 0.03 between static weight bearing and force plate PVF indicating a fair and slight agreement, respectively. The Kappa values of all evaluation methods in comparison to the bathroom scales are presented in Table 2.

Discussion

The overall test-retest reliability of the static weight bearing measurements performed with the bathroom scales was greater than 50% in all of the observed variables. The results of this study indicated that the repeatability of static weight bearing using bathroom scales was higher in OA dogs than in the control group dogs. The overall repeatability was 11% better in the affected than in the unaffected hindlimbs of OA dogs. Dogs in the OA group may have displayed a learned pattern of weight bearing due to OA pain or biomechanical changes after cranial cruciate ligament surgery. These may have led to a controlled and repetitive pattern of weight bearing. This is supported by the previous findings of horses having more repeatable stride length when lame than when pain-free (26).

Healthy individuals have no reason to focus on how they alter the weight between their limbs, thus displaying lower repeatability. A former study also showed asymmetry in hindlimb mechanics of healthy dogs (27). We found the repeatability to be 10% better in the right than in the left hindlimbs of the control dogs for reasons that are unclear to us.

The difference in static weight bearing between the hindlimbs can be evaluated manually to an extent, but not accurately enough to be considered good practice. A normal difference between the hindlimbs was in this study defined as six percent when proportional to the total weight of the dog. Manual evaluation was, however, not more than 59.5% accurate in estimating symmetry at a greater than five percent level. Therefore, when using manual evaluation, not only does the accuracy of the evaluation leave room for improvement, but it is also a weaker subjective outcome measure, and is inadequate as the only evaluation method. Considering the gross accuracy of manual testing for differences by static weight bearing in the hindlimbs, it should also be noted that manually assessing differences in static weight bearing, especially in small dogs, can be challenging. In addition, the handedness of the examiner could have affected the results of manual evaluation, as well as the chirality of the dogs (26).

The agreement between the bathroom scales and the force platform was variable. In the group of severe OA findings the Kappa coefficient value for IMP was mod-
erate and fair for PVF. In the not-severe group, clearly weak kappa coefficient values were noted. These findings were supported by the averaged proportion of agreement: for severe OA findings IMP was 57% and PVF 45%, and for not-severe OA findings IMP was 41% and PVF 36%. We recognize that the two devices measure two different things: static weight bearing and dynamic weight bearing. We therefore concluded that since dogs functionally must cope in their environments with both static and dynamic forces, and their responses to these different states may vary, both outcome measures are informative and of high interest to those evaluating functional outcome of the rehabilitation of dogs with OA in the hindlimbs.

An important result of the study was the actual value of the normal difference in weight bearing proportional to the total weight of the dog: 3.3%. It should be pointed out that the SD (± 2.7%) was quite high, thus almost doubling the absolute value and setting the cut-off for normal difference to six percent. The small population of control dogs in our study may have affected the accuracy of the result. The control dogs had no clinical signs reported by the owner, or detected in the orthopaedic examination, and all of the dogs were young and had radiographic screening results free of hip dysplasia. Therefore there was no reason to expect them to have OA, but this was not confirmed. However, a preliminary guideline for normal and acceptable variance in static weight bearing was presented.

Specificity of a test means that it is able to find the healthy ones and sensitivity of a test means that it is better at finding the diseased ones. It can be concluded that if measuring static weight bearing with bathroom scales and wanting to know when rehabilitation is sufficient, higher specificity is useful. The specificity of the test was 0.85 whereas the sensitivity was 0.39. Therefore, one weakness of the method of measuring static weight bearing with bathroom scales is the low sensitivity, meaning that it accepts many individuals with OA findings as having sufficient symmetrical static weight bearing between the hindlimbs, thus considering them sound. Two factors in this study may explain this phenomenon. Firstly, since the number of dogs in the control group was limited, the SD was high. If a larger population had been used, the SD could have become reduced, resulting in a lower cut-off value for normal, thereby increasing the sensitivity. Secondly, the only inclusion criteria for this study were the OA findings. Despite the OA findings from the radiographic or even orthopaedic examinations, the dogs we used may have been symptom-free (pain-free, no alterations in joint biomechanics). Therefore, the poor sensitivity may also have been due to case selection and requires future study.

A challenge of the study was the different classifications of various assessments. Manual evaluation, quantitative measurement of static weight bearing, and force platform had three different classifications whereas orthopaedic, radiographic, and conclusive assessment had four. This may have affected the agreement (Table 1). For example, in the quantitative measurement there were OA dogs with symmetrical static weight bearing, whereas the orthopaedic examination found no bilaterally symptom-free dogs, but several bilaterally abnormal dogs. Since the static weight bearing measurement does not differentiate the quality of symmetry, the bilaterally abnormal dogs as well as the bilaterally normal dogs have both fallen into the same group of symmetrical findings, which may have weakened the agreement. In addition, the congruity and agreement percentages were small, due to the fact that not all the examination and evaluation methods measure static weight bearing. Even though trotting at less than the set velocity limit, two dogs were included in the force platform analysis. Our interest in this study was in the difference in weight bearing and asymmetry within one dog. Hence it was assumed, that the two dogs with low velocity still had the same weight bearing ratio bilaterally, and could therefore be used. However, the effect of velocity on the symmetry indices has not yet been studied in dogs. In addition, even if their results may have had a small effect on the mean, the effect was still considered to be minimal.

A limitation of the study is that weight distribution was measured only between the hindlimbs. Any possible individual compensation in weight bearing towards the forelimbs was therefore ignored. This was, however, to some extent considered when the difference between the hindlimb static weight bearing was proportional to the total body weight of the dog. Another limitation was the heterogenous population we used. As dogs had previously been operated on using many different techniques, this might have influenced our results. Also the fact that the bathroom scales were not calibrated against known masses each time, but measurements relied upon the factory calibration of the scales, should be taken into consideration.

To gain more information on the functional weight distribution of the dog, it would have been beneficial to measure the distribution between all four limbs. However, electronic force platforms and pressure walkways may be cost prohibitive for some. In our clinical experience, using four bathroom scales – one under each limb – was in practice difficult and non-rewarding. Two bathroom scales that measure only the difference between the hindlimbs are specific enough to recognize the normal static weight bearing distribution, and it can be reliably used as an outcome measure.

We conclude that bathroom scales can be used as a reliable, objective measurement tool at minimal expense when measuring and evaluating the symmetry of static weight bearing in dogs with hindlimb OA. The method and a preliminary cut-off point of normal variance have been presented. By measuring static weight bearing, healthy individuals can be differentiated from diseased ones, with a low risk of false negatives. Bathroom scales can be used as an outcome measure when rehabilitating dogs with osteoarthritic changes in the hindlimbs, but should be further tested with larger populations and for other diagnoses.

Conflicts of Interest
None declared.
References