Use of pressure platform gait analysis in cats with and without bilateral onychectomy

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Objective—To determine peak vertical force (PVF) and vertical impulse (VI) in cats that had or had not undergone bilateral forelimb onychectomy.

Animals—26 healthy adult cats.

Procedure—Onychectomized cats (n = 13) had undergone surgery more than 6 months prior to the study. The PVF and VI were collected from all limbs of each cat with a 2-m pressure platform walkway. Cats were allowed to walk at a comfortable velocity, and acceleration was restricted to $\pm$ 0.5 m/s^2. Five valid trials were recorded for each cat with all trials collected in a single 1-hour session. All forces were normalized to and expressed as a percentage of the cat's body weight.

Results—Gait data were successfully collected in all cats. No significant difference was found for PVF or VI between cats that had or had not had onychectomy. Limb loads were greater in forelimbs than hind limbs for all trials. Mean PVF and VI in the forelimbs of cats in the nononychectomy group were 56.41% and 18.85%, respectively. Mean PVF and VI in the hind limbs of cats in the nononychectomy group were 50.22% and 14.56%, respectively.

Conclusions and Clinical Relevance—Gait analysis was successfully performed in cats with a pressure platform walkway. The absence of differences in PVF and VI between the 2 groups of cats suggests that bilateral forelimb onychectomy did not result in altered vertical forces measured more than 6 months after surgery in cats. (*Am J Vet Res* 2004;65:1276–1278)

Approximately 14 million cats undergo onychectomy each year.[1] Although many receive medications for postoperative pain, defining the most effective protocol is limited by the inability to objectively compare analgesic regimens. Additionally, there are several onychectomy techniques. Claims have been made that onychectomy performed with a laser is less painful, compared with other surgical techniques.[1,2] In a recent study[3] that used a numerical rating system to estimate level of pain, it was reported that onychectomy with a laser technique resulted in less discomfort and fewer complications. That study, however, was limited by the subjective nature of the patient evaluations. Subjective evaluations often yield inconsistent results because of interobserver variation in interpretation of pain and because the observed behavior may not accurately portray the degree of pain.[4,5] Unfortunately, there are no objective physiologic measurements that consistently determine the level of pain in dogs or cats.[5,6]

An objective, reliable, noninvasive method for quantifying postoperative pain and limb function in cats after onychectomy would be beneficial. Force platform gait analysis is an accurate, precise, and objective tool for measuring limb function in dogs.[7,8] Unfortunately, traditional force platform gait analysis is not conducive to evaluation of animals after surgery because of inconsistent stride length and is difficult in cats because of their short stride length. Pressure platform gait analysis does not have these limitations. Pressure platforms have been evaluated by numerous laboratories and are precise and accurate.[9-12] In addition, pressure platforms are a suitable alternative to a force platform for generating **peak vertical force (PVF)** and **vertical impulse (VI)** data in dogs.[9]

The purposes of the study reported here were to determine whether limb function could be measured in cats by use of pressure platform gait analysis, describe the vertical forces found in clinically normal cats, and compare those forces with those of cats that underwent onychectomy more than 6 months prior to the study. Our hypotheses were that pressure platform gait analysis could be successfully performed in cats, the distribution of vertical forces in the fore- and hind limbs of cats would be similar to that reported in dogs, and vertical forces would be similar between cats that had and had not undergone onychectomy more than 6 months after surgery.

Materials and Methods

Healthy client-owned adult cats (n = 13) that had not undergone onychectomy were recruited as controls for this study. In addition, cats (n = 13) that had a successful outcome after bilateral forelimb onychectomy more than 6 months before this study were recruited. Prior to inclusion in the study, the owner of each cat signed an informed client consent form and each cat was determined to be clinically normal on the basis of owner history and physical examination results, with an emphasis on detecting orthopedic or neurologic abnormalities. The protocol for this study was approved by Iowa State University's Committee on Animal Care.

A 2 $\times$ 0.75-m pressure measurement platform[a] was placed in the center of and level with a 10-m runway. The platform was linked to a dedicated computer[b] with specific software[c] designed for collection of gait analysis data. Prior to data acquisition, the walkway sensors were equilibrated and calibrated in accordance with manufacturer specifications.[13]

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Preceding data collection, each cat was weighed on an electronic scale[d] and allowed to acclimate itself to the runway area and pressure platform.

Cats were allowed to walk across the pressure platform at a comfortable velocity. Data were collected from all limbs of each cat for consecutive footfalls. Five valid trials were recorded for each cat, and all trials were collected in a single 1-hour session. A valid trial consisted of the cat walking at a comfortable velocity and each of the 4 limbs fully contacting the walkway at least 2 consecutive times during the pass. A single observer evaluated each trial and determined whether a trial was valid or not. Pressure distribution data (PVF and VI) were collected from each footfall for each of the 5 valid trials. All forces were normalized to and expressed as a percentage of the cat's body weight.

Statistical analyses—Summary statistics were calculated for all variables, and repeated measures ANOVA was performed.[14] A *t* test was used to evaluate group differences in body weight, velocity, and acceleration. Match-paired *t* tests were used to compare the left forelimb (and hind limb) with the right forelimb (and hind limb) for PVF and VI to ensure that forelimbs (and hind limbs) were not significantly different. In addition, distribution of velocity was performed to determine whether regression analysis was needed. Regression analysis would be required if velocity was significantly different between groups. Regression analysis did not need to be performed. Significance for comparisons between limbs was set at $P < 0.05$, and data were expressed as mean ± SD. All analyses were performed by use of computer software.[e]

Results

No significant difference was found between groups for sex, breed, or age. Cats in the control group had a mean body weight of 4.70 ± 0.38 kg, whereas cats in the onychectomy group had a mean body weight of 5.31 ± 0.38 kg ($P = 0.27$). Mean age of the cats in the control group was 3.0 ± 0.47 years, and mean age of the cats in the onychectomy group was 4.42 ± 0.84 years. Gait analysis was successfully performed in 13 of 13 cats in both groups. Although cats were allowed to establish their own gait velocity, there was no significant difference in mean gait velocity ($P = 0.45$) or acceleration ($P = 0.41$) between groups. In addition, there was no difference in the distribution of trial velocities between groups. Cats in the control group had a mean velocity of 0.69 ± 0.029 m/s, and cats in the onychectomy group had a mean velocity of 0.66 ± 0.029 m/s.

No significant difference was found between the left and right forelimb for cats in the control ($P = 0.57$) or onychectomy ($P = 0.99$) group for PVF, and there was no difference between groups for PVF ($P = 0.66$; **Figure 1**). Mean PVF for the forelimbs of cats in the control group was 56.41 ± 1.44% of body weight, and mean PVF for the forelimbs of cats in the onychectomy group was 53.04 ± 1.44%. Similarly, no significant difference was found between the forelimbs for cats in the control or onychectomy group for VI (control, $P = 0.67$; onychectomy, $P = 0.61$), and no significant difference existed between groups for VI ($P = 0.50$; **Figure 2**). Mean VI for the forelimbs of cats in the control group was 18.85 ± 0.85%, and mean VI for cats in the onychectomy group was 18.09 ± 0.84%.

Limb loads were greater in the forelimbs than hind limbs for all trials. No significant difference was found between the left and right hind limbs for cats in the control ($P = 0.42$) or onychectomy ($P = 0.89$) group for PVF, and there was no difference between groups for PVF ($P = 0.42$). Mean PVF for the hind limbs of cats in the control group was 50.22 ± 1.31%, and mean PVF for the hind limbs of cats in the onychectomy group was 47.45 ± 2.28%. Similarly, no difference was found in the hind limbs between cats in the control ($P = 0.14$) and onychectomy ($P = 0.72$) groups for VI, and no difference existed between groups for VI ($P = 0.50$). Mean VI for the hind limbs of cats in the control group was 14.56 ± 0.70%, and mean VI for cats in the onychectomy group was 15.01 ± 0.66%.

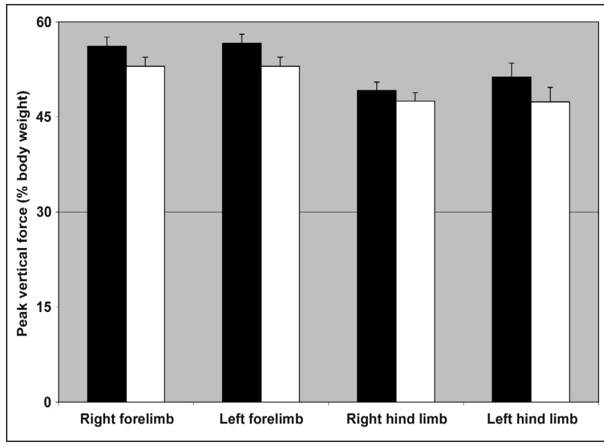

Figure 1—Mean ± SD peak vertical force in cats at a walk that either had (open bars) or had not (solid bars) undergone onychectomy.

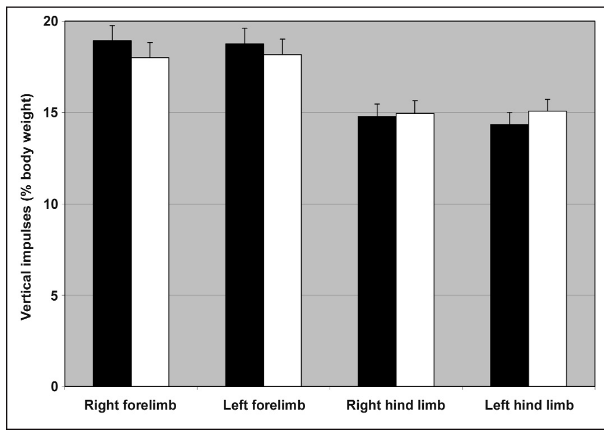

Figure 2—Mean ± SD vertical impulse in cats at a walk that either had (open bars) or had not (solid bars) undergone onychectomy.

Discussion

In this study, we demonstrated that gait analysis could be successfully performed in cats. Computer-generated gait analysis has proven to be beneficial in the evaluation of lameness in dogs and is commonly used to test treatment effects of surgical procedures and pharmaceuticals.[15,16] Similar situations that exist in cats would benefit from objective evaluation of limb function. In several recent studies[16-19] on analgesic protocols used for onychectomy, only subjective evaluations were used to assign a pain score. However, if these subjective measurements were combined with an objective measure of a cat's willingness to use the operated limbs, better estimation of the amount of pain experienced by the cat would be possible.

We were also able to determine that when measured at least 6 months after onychectomy, vertical forces are similar between cats that have and have not had onychectomy. Because we failed to reject the null hypothesis, we need to address the probability of a type II error. As an example, we determined the statistical power for forelimb VI between groups, which is arguably the single most important variable reported. With 13 cats in each group, the power is 59%. In effect, there is a 41% chance that there is a type II error. However, it is important to note that the probability of a statistical error does not change the difference between the means of each group. In this example, the difference between the means is quite small (control, 18.85; onychectomy, 18.09) and consistent with our finding of no significant difference between groups, so we believe that the difference between means is also not likely to be clinically important.

In the cats in the onychectomy group, onychectomy was performed by either scalpel or laser excision. Although there was an equal distribution in the frequency that either procedure was performed, we made no attempt to discriminate differences between those procedures. In addition, for the purposes of future studies that use this gait analysis method in cats, cats with or without previous onychectomy can be grouped; a successful outcome after previous onychectomy may not need to be considered as an additional variable.

Finally, the distribution of vertical forces at a walk between the fore- and hind limbs in cats is similar to that in dogs. In a recent study, mean PVF for the forelimb of Greyhounds was 58.11% and mean PVF of the hind limb was 42.05%.[9] Similarly, vertical forces in the forelimbs of our control cats were greater than that in the hind limbs. However, if we consider the mean PVF reported here (forelimb, 56.41%; hind limb, 50.22%), it is apparent that the disparity between fore- and hind limb forces in cats is much less. However, the importance of this species difference is not known.

Gait analysis in small dogs and cats with a traditional force platform[7,8] is difficult because of their short stride length and the manner in which force platforms and their associated software collect and process the data. The pressure platform allows for the collection of vertical force data in these small animals. Although collecting gait data from some cats required a bit of encouragement and investigator patience, we were able to collect satisfactory data from every cat. The system has reported limitations[9]; however, it functions as an acceptable alternative to force platform gait analysis and provides investigators with an objective method for measuring limb function in cats.

[a]Tekscan Inc, South Boston, Mass.
[b]Latitude CPx personal laptop, Dell Computer Corp, Round Rock, Tex.
[c]I-scan, version 4.20, Tekscan Inc, South Boston, Mass.
[d]Vet-50 electronic scale, Detecto-Cardinal scale, Webb City, Mo.
[e]JMP, version 5.0.01, SAS Institute Inc, Cary, NC.

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