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The accuracy of the patellar reflex for localization of the site of a single level thoracolumbar disc herniation in dogs

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Abstract: The patellar reflex was used in this study to determine the site of thoracolumbar spinal cord dysfunction (T3–L3 or L4–L6) as a result of disc herniation. The results of neurological examinations were compared with the findings of CT myelography. This study was conducted on 21 dogs, selected from a total of 26 dogs confirmed to have a single thoracolumbar lesion. Results revealed that the accuracy of the patellar reflex for lesion localization was 71.4%. The accuracy of the patellar reflex (normal or hyperreflexic) for lesion localization in the T3–L3 segment in 15 dogs was 100%, while the accuracy of the depressed patellar reflex for lesion localization in the L4–L6 segment in 6 dogs was 0%. The accuracy of the patellar reflex for detection of laterality of a thoracolumbar lesion was low (33.33%). The results suggest that the patellar reflex was not reliable for neurolocalization of thoracolumbar spinal cord lesions in dogs. This could be related to the fact that the depressed reflex did not always refer to a lesion in the L4–L6 spinal cord segment. Moreover, the patellar reflex was not reliable in detecting the laterality of thoracolumbar lesions.

Key words: Accuracy, CT myelography, dogs, patellar reflex, thoracolumbar disc herniation

1. Introduction

Advanced diagnostic tools such as computed tomography (CT) and magnetic resonance imaging (MRI) have reduced the reliance on primary tools such as neurological examination and radiography for neurolocalization of spinal cord lesions (1). The neurological examination forms an integral role of the overall diagnostic process and provides a foundation for further diagnostic procedures such as cerebrospinal fluid analysis, advanced imaging, and electrodiagnostics. The accurate assessment of postural reactions and spinal reflexes during neurological examination helps neurologists and clinicians in localizing spinal cord lesions (2,3).

Several studies investigated the value of neurological examinations to detect spinal cord lesions. One of these studies used the withdrawal reflex for determination of cervical disc herniation in dogs. The results of that study suggested that the withdrawal reflex was not reliable for lesion site detection (4). A further study was conducted to evaluate the cutaneous trunci reflex for the detection and grading of thoracolumbar spinal cord injuries in dogs. The results revealed that the cutaneous trunci reflex helped in the localization of thoracolumbar lesions and divided dogs with ambulatory paresis into mild and severe categories (5). A retrospective study was performed to determine the accuracy of the patellar reflex in neurolocalization of thoracolumbar lesions. The results showed that the accuracy of the patellar reflex to determine whether the lesions were in the upper motor neurons (UMNs) or in the lower motor neurons (LMNs) in dogs with single and multiple thoracolumbar lesions was about 87% (1).

The patellar reflex is considered the most reliable tendon reflex used in neurological examinations. It is a monosynaptic myotatic (stretch) reflex. It is mediated by the femoral nerve through the spinal cord segments L4–L6. Therefore, it evaluates the integrity of spinal cord segments (L4–L6 and its associated nerve roots) as well as the femoral nerve (6).

The thoracolumbar region of the spinal cord is divided functionally into two parts: the cranial (T3–L3, UMNs for pelvic limbs) and the caudal (L4–S3, LMNs for the pelvic limbs) (6). The depression or loss of patellar reflex refers to lesions within the reflex arc of LMNs, whereas a normal or hyperreflexic patellar reflex implies the lesion is occurring

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cranial to the spinal cord segment containing the reflex arc of UMNs (7).

In this study we aimed to investigate the accuracy of the patellar reflex as a reliable test for neurolocalization of a single level spinal cord lesion associated with thoracolumbar disc herniation in dogs, as well as the laterality of the lesion, and to compare these findings with the findings of CT myelography.

2. Materials and methods

The medical records of 26 dogs with confirmed thoracolumbar herniation that were presented at the Veterinary Teaching Hospital of Iwate University, Japan, from July 2008 to May 2012 were reviewed. Animals suffering from a single level lesion according to the results of neurological examinations, CTs, and CT myelography were selected. The hind limbs of the selected dogs in this study were free of orthopedic lesions. Data collected from the medical records included signalment of the animals (age, breed, sex, neutering status), chief complaint, onset of clinical signs, duration of clinical signs, and previous treatment. The general physical examination of the dogs included measuring the temperature, heart rate, respiratory rate, and capillary refill time, and checking for superficial lymph nodes.

The neurological examination was performed according to the grading scale of the Small Animal Hospital of Iwate University, Japan, which is divided into 5 grades as reported by Sharp and Wheeler (8). The results of the patellar reflex were collected. The patellar reflex was performed in all dogs by two specialized neurologists (some of the patients were examined by one of the neurologists and the rest of the patients by another neurologist) through tapping of the patellar ligament using a flexor hammer when the animal was in lateral recumbency and the limb under examination was in a slight flexion, supported by placing one hand under the thigh. A normal animal's response to the stimulus is extension of the limb. The results of the patellar reflex examination were graded as areflexia (0), hyporeflexia (1), normal (2), and hyperreflexia (3).

CT myelography was performed in the normal manner by injecting 0.4 mg/kg iohexol 240 (Omnipaque 240 Note, Daiichi Sankyo Co., Ltd.) into the subarachnoid space at the L5–L6 intervertebral space. Transverse image slices of 0.5 mm thickness and dorsal and sagittal sections were reformatted using the CT machine (Toshiba helical CT, Asteion, Toshiba medical Co, 4-detector). The animals were subjected to decompressive surgery (hemilaminectomy) after the confirmation of thoracolumbar herniation.

The dogs were monitored after surgery for the recovery of motor function and neurological improvement. The follow-up of the dogs started immediately after surgery, with duration ranging between 15 and 585 days (with a mean of 101.33 days).

2.1. Excluded cases

A lesion localized at the intervertebral disc space L2–L3 [the junction between spinal cord regions T3–L3 (UMNs) and L4–S3 (LMNs)] may or may not be responsible for the decreased patellar reflex (6). Due to the local variability of the spinal cord segments relative to the vertebral bodies, it was difficult to make a definitive determination of the localization of the lesion. In the case of a lesion at L2–L3, both the UMNs and LMNs are correct, so the dogs that had an L2–L3 lesion confirmed on CT myelography were excluded from the statistical evaluation.

Moreover, lesions that were detected caudal to the spinal segment (L6) were excluded due to the femoral nerve that mediates the patellar reflex derived from L4–L6. Therefore, dogs with lesions caudal to the L6 segment (L5 vertebra) were also excluded from the statistical evaluation. A total of five dogs were excluded from the statistical analysis.

2.2. Statistical analysis

Data were analyzed using a commercially available software package (GraphPad Prism Version 5.0, GraphPad Software). The statistical analysis was performed using the Pearson linear correlation to determine the associations between the age of the animals and the duration of clinical signs with the postoperative duration of recovery. Also, the correlation between neurological grades and postoperative duration was determined. The linear correlation coefficient r and 95% CI were reported. Moreover, the chi-square test was used to determine the association between the weight and breed of the animals with the clinical grades of neurological dysfunction. Values of $P < 0.05$ were considered significant.

3. Results

Twenty-six dogs were selected for this study, of which 23 were small (<10 kg) and 3 were medium-sized dogs (10 to 20 kg), representing five breeds (21 Miniature dachshund (80.8%), one Standard dachshund, one Maltese, one Cavalier King Charles spaniel, and two Beagles). Ages ranged from 3 to 13 years (with a mean of 6.46 years). There were 13 males (nine intact and four castrated) and 13 females (10 intact and three spayed). All dogs had a chronic onset of clinical signs (3 days to 3 months). The postoperative duration of recovery was not associated with the age of the animals ($r = 0.06$, $P = 0.97$), the duration of clinical signs ($r = 0.035$, $P = 0.8628$), or the preoperative neurological grade ($r = 0.006$, $P = 0.9767$). The results also revealed a lack of association between the weight ($P = 0.38$) and the breed of the animals ($P = 0.47$) with the clinical grades of neurological dysfunction.

The neurological examination of 21 out of the 26 dogs revealed that five dogs (23.8%) had grade III, 12 dogs (57.2%) had grade IV, and 4 dogs (19%) had grade V neurological dysfunction. According to the neurological examination, 15 dogs had lesions in the T3–L3 spinal cord region, and six dogs had lesions in the L4–L6 spinal region. The patellar reflex was considered normal and hyperreflexic in 15 dogs (71.4%), and was depressed in six dogs (28.6%). However, the CT myelography revealed that all dogs had lesions within the spinal region T3–L3 [T10–T11 (n = 1), T11–T12 (n = 4), T12–T13 (n = 8), T13–L1 (n = 3), and L1–L2 (n = 5)]. The most common site of thoracolumbar disc herniation detected by CT myelography was T12–T13 (eight dogs, 38%).

The accuracy of the patellar reflex for neurolocalization of spinal cord dysfunction was 71.4% when compared with CT myelography in this study. The association of neurological examination (patellar reflex) for the detection of the site of a thoracolumbar lesion relative to CT myelography is shown in Figure 1.

It was observed that six dogs (28.6%) for whom the patellar reflex was inconsistent with CT myelography were female with ages ranging from 3 to 13 years (with a mean of 7 years).

The CT myelography displayed the lateralization of lesions in all dogs [left side (12 dogs, 57.14%) and right side (nine dogs, 42.86%)]. However, the patellar reflex revealed asymmetry of the spinal cord lesion in seven dogs [33.33%, (5 (L) and 2 (R)] and symmetry of the spinal cord lesion in 14 dogs (66.67%) (Figure 2).

4. Discussion

The accuracy of the patellar reflex in this study for localization of thoracolumbar spinal cord lesions was 71.4% when compared with the CT myelographic findings. Therefore, the reliance upon the patellar reflex as a reliable method for the detection of the site of a single level thoracolumbar lesion in dogs is not sufficient, and other advanced tools are required to achieve this purpose. The accuracy of the patellar reflex in this study is lower than that reported in a previous study (1), where the patellar reflex helped the authors to correctly classify 114 out of 131 cases (87%) as hyperreflexic, indicating that the lesions were within the UMN region (T3–L3), but when the patellar reflex was assessed as depressed, it indicated a lesion in the LMNs (L4–S3), which was correct in two out of 12 patients.

In this study the accuracy of the patellar reflex when hyperreflexic was 100%, while its accuracy when depressed or hyporeflexic was 0%. This may be due to the large number of lesions that occur in the UMN region (T3–L3) of the spinal cord in contrast to the lesions that occur in the LMN region of the spinal cord (L4–S3). This may lead to a decrease in the positive predictive value of the patellar reflex for determination of LMN spinal cord lesions (1).

The age of the animals is considered one of the factors that might affect the results of the patellar reflex. In dogs, the aging period may start as early as 7 years old (9), and the mean age of dogs that had a depressed reflex in this study was 7 years. Therefore, dogs ≥7 years may be associated with a prolongation of the total reflex time, leading to a decrease

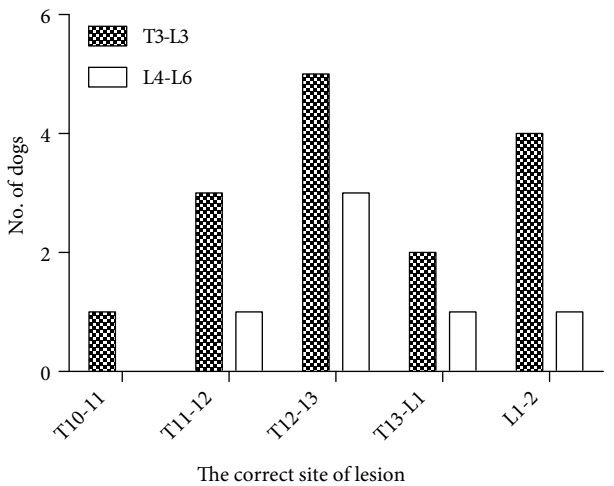

Figure 1. Association between the anatomic site of lesions (results of CT myelography) and the results of patellar reflex of 21 dogs that had a single level thoracolumbar lesion [shaded bars are the correct anatomic localizations of the patellar reflex (15 dogs); white bars are the incorrect anatomic localizations of the patellar reflex (6 dogs)].

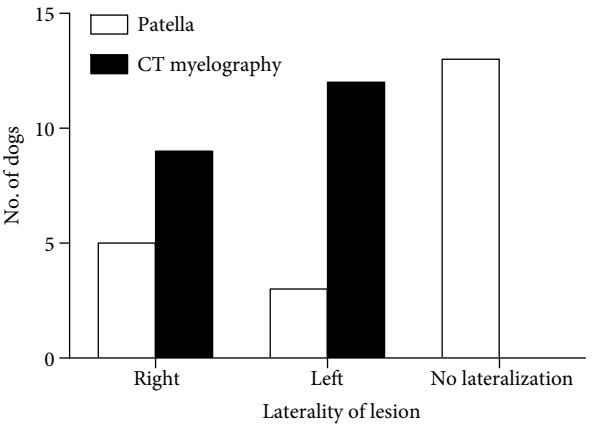

Figure 2. Accuracy of the patellar reflex and CT myelography in detection of lesion laterality in 21 dogs with a single level thoracolumbar disc disease.

in the magnitude of the patellar reflex (10). This influence of age upon the total reflex time may be attributed to age related changes such as demyelination, ballooning, and remyelination that occur in the dorsal and ventral nerve roots as reported in a study conducted on the lumbar spine in humans (11). However, the results of a previous study in humans suggested the opposite view, that age did not have any influence upon the patellar reflex (12).

Also, the depression of the patellar reflex in dogs may be attributed to the chronic compression of the spinal cord that may result in some pathological changes such as demyelination, edema, axonal degeneration, and neuronal necrosis of the spinal cord parenchyma as was reported in humans (13) and horses (14). These changes, especially the chronic demyelination, may lead to the exposure of rapidly activating potassium channels along the axon (15), which may lead to blocking of the action potential propagation (16) and reduction in the excitability of motor neurons, and finally a depression of the reflex will occur (17). In the same way, the nerve roots of the pelvic limb are also liable for demyelination, which leads to hyporeflexia and depression of the patellar reflex, similar to that occurring in degenerative myelopathy (Canine degenerative radiculomyelopathy) (18,19). Moreover, the necrosis of glia cells is considered one of the results of chronic compression of the spinal cord (13,14). One of the functions of these cells is to remove and clear excess glutamate (a neurotransmitter) (20), which was detected in high levels in the cerebrospinal fluid of dogs that had chronic compressive thoracolumbar lesions (21). Accumulation of glutamate, which has an excitotoxic effect on neurons, especially postsynaptic ones (20), may lead to depression of the patellar reflex in animals.

The difficulty of accurate localization of the lesion may also be attributed to spinal shock, which is characterized by a loss of muscle tone and segmental spinal reflexes for a few hours from the onset as a result of peracute severe transverse spinal cord injury (22,23). Hypotonia is considered the only sign that may persist for 10–14 days, until it is replaced initially with normal tone, followed by hypertonia. The ways in which UMN pathway interruption can lead to LMN signs are not clear. One explanation of this phenomenon is the sudden loss of UMN synapse as a result of a peracute lesion, leading to the loss of LMN cell function for a variable period of time (22). However, this may be inconsistent with our study, because the six dogs with depressed patellar reflex presented chronic onset (5–11 days) of clinical signs.

This study is in agreement with previous studies that detected the thoracolumbar herniation in the spinal cord region from T10 to L2, and the T13–L1 is considered the most common site of thoracolumbar disc herniation (38%) (1,24).

Both myelography and CT are reasonable and practical diagnostic imaging modalities for detection of the site of disc herniation. CT is more sensitive than myelography in chronically affected dogs, while myelography is more sensitive than CT in small-sized dogs (<5 kg) (25,26). Moreover, the sensitivity of myelography for localization of lesions in dogs with intervertebral disc disease ranged from 53% to 94.7% (26–28), while the sensitivity of conventional CT for the detection of the site of lesions in dogs ranged from 81% to 100%, as reported in previous studies (26–29). The range of the values of CT sensitivity may be due to CT's ineffectiveness in the diagnosis of conditions that do not involve mineralization of extruded disc material (30). Therefore, in this study the combination of myelography and CT was performed to achieve an effective and accurate method for the detection of thoracolumbar lesions (28,30).

All dogs in the current study underwent hemilaminectomy according to the findings of CT myelography, which is considered a reliable method for lateralization of the lesions. However, the clinical lateralization of the herniated disc material was found to be the least reliable factor in this study for determining on which side the hemilaminectomy should be performed (31).

In conclusion, the patellar reflex has a low accuracy for neurolocalization of a single thoracolumbar spinal cord lesion in dogs, which may be related to the depressed patellar reflex not always indicating a lesion at the L4–L6 spinal cord segment. Also, the patellar reflex is not considered a reliable method for detection of lesion laterality.

References

1. Murakami T, Feeney DA, Willey JL, Carlin BP. Evaluation of the accuracy of neurologic data, survey radiographic results, or both for localization of the site of thoracolumbar intervertebral disk herniation in dogs. Am J Vet Res 2014; 75: 251–259.
2. Braund KG, Sharp NJH. Neurological examination and localization. In: Slatter DH, editor. Textbook of Small Animal Surgery. 3rd ed. Philadelphia, PA, USA: WB Saunders; 2003. pp. 1092–1107.
3. Williams BW, Dewey CW. Performing the neurological examination. In: Dewey CW, editor. A Practical Guide to Canine and Feline Neurology. 1st ed. Ames, IA, USA: Iowa State Press; 2003. pp. 31–57.
4. Forterre F, Konar M, Tomek A, Doherr M, Howard J, Spreng D, Vandevelde M, Jaggy A. Accuracy of the withdrawal reflex for localization of the site of cervical disk herniation in dogs: 35 cases (2004–2007). J Am Vet Med Assoc 2008; 232: 559–563.

5. Gutierrez-Quintana R, Edgar J, Wessmann A, Cherubini GB, Penderis J. The cutaneous trunci reflex for localizing and grading thoracolumbar spinal injuries in dogs. J Small Anim Pract 2012; 53: 470–475.

6. Garosi L. Lesion localization and differential diagnosis. In: Platt SR, Olby NJ, editors. BSAVA Manual of Canine and Feline Neurology. 3rd ed. Gloucester, UK: British Small Animal Veterinary Association; 2004. pp. 24–34.

7. Schatzberg SJ, Kent M, Platt SR. Neurologic examination and neuroanatomic diagnosis. In: Tobias KM, Johnston SA, editors. Veterinary Surgery: Small Animal. 1st ed. Volume I. St. Louis, MO, USA: Saunders; 2012. pp. 325–339.

8. Sharp N, Wheeler S. Thoracolumbar disc disease. In: Small Animal Spinal Disorders: Diagnosis and Surgery. 2nd ed. Edinburgh, UK: Mosby; 2005. pp. 121–159.

9. Geer KA, Canterberry SA, Murphy KE. Statistical analysis regarding the effects of height and weight on life span of the domestic dog. Res Vet Sci 2007; 82: 208–214.

10. Levine JM, Hillman RB, Erb HN, deLahunta A. The influence of age on patellar reflex response in the dog. J Vet Intern Med 2002; 16: 244–246.

11. Griffiths IR, Duncan ID. Age changes in the dorsal and ventral lumbar nerve roots of dogs. Acta Neuropathol (Berl) 1975; 32: 75–85.

12. Clarkson PM. The relationship of age and level of physical activity with the fractionated components of patellar reflex time. J Gerontol 1978; 33: 650–656.

13. Bunge RP, Puckett WR, Becerra JL, Marcillo A, Quencer RM. Observations on the pathology of human spinal cord injury: a review and classification of 22 new cases with details from a case of chronic cord compression with extensive focal demyelination. Adv Neurol 1993; 59: 75–89.

14. Yovich JV, Gould DH, Lecouteur RA. Ultrastructural alterations in the spinal cord of horses with chronic cervical compressive myelopathy. Prog Vet Neurol 1992; 3: 13–19.

15. Blight AR, Young W. Central axons in injured cat spinal cord recover electrophysiological function following remyelination by Schwann cells. J Neurol Sci 1989; 91:15–34.

16. Olby NJ, Jeffery ND. Pathogenesis and physiology of central nervous system disease and injury. In: Tobias KM, Johnston SA, editors. Veterinary Surgery Small Animal, 1st ed. Volume I. St. Louis, MO, USA: Saunders; 2012. pp. 374–387.

17. Grossman SD, Wrathall JR. The role of activity blockade on glutamate receptor subunit expression in the spinal cord. Brain Res 2000; 880: 183–186.

18. Averill DR Jr. Degenerative myelopathy in the aging German shepherd dog: clinical and pathologic findings. J Am Vet Med Assoc 1973; 162: 1045–1051.

19. Griffiths IR, Duncan ID. Chronic degenerative radiculomyelopathy in the dog. J Small Anim Pract 1975; 16: 461–471.

20. Maxie MG, Youssef S. Nervous system. In: Maxie MG, editor. Jubb, Kennedy and Palmer's Pathology of Domestic Animals. 5th ed. Volume 1. St. Louis, MO, USA: Saunders; 2006. pp. 281–457.

21. Olby NJ, Sharp NJ, Munana KR, Papich MG. Chronic and acute compressive spinal cord lesions in dogs due to intervertebral disc herniation are associated with elevation in lumbar cerebrospinal fluid glutamate concentration. J Neurotraum 1999; 16: 1215–1224.

22. De Lahunta A, Glass E. Upper motor neuron. In: De Lahunta A, Glass E, editors. Veterinary Neuroanatomy and Clinical Neurology. 3rd ed. St. Louis, MO, USA: Saunders; 2009. pp. 243–284.

23. Smith PM, Jeffery ND. Spinal shock–comparative aspects and clinical relevance. J Vet Intern Med 2005; 19: 788–793.

24. Levine J, Fosgate G, Chen A, Rushing R, Nghiem P, Platt S, Bagley R, Kent M, Hicks D, Young B. Magnetic resonance imaging in dogs with neurologic impairment due to acute thoracic and lumbar intervertebral disk herniation. J Vet Intern Med 2009; 23: 1220–1226.

25. Cooper JJ, Young BD, Griffin JF, Fosgate GT, Levine JM. Comparison between noncontrast computed tomography and magnetic resonance imaging for detection and characterization of thoracolumbar myelopathy caused by intervertebral disk herniation in dogs. Vet Radiol Ultrasoun 2014; 55: 182–189.

26. Israel SK, Levine JM, Kerwin SC, Levine GJ, Fosgate GT. The relative sensitivity of computed tomography and myelography for identification of thoracolumbar intervertebral disk herniations in dogs. Vet Radiol Ultrasoun 2009; 50: 247–252.

27. Hecht S, Thomas WB, Marioni-Henry K, Echandi RL, Matthews AR, Adams WH. Myelography vs. computed tomography in the evaluation of acute thoracolumbar intervertebral disc extrusion in chondrodystrophic dogs. Vet Radiol Ultrasoun 2009; 50: 353–359.

28. Newcomb B, Arble J, Rochat M, Pechman R, Payton M. Comparison of computed tomography and myelography to a reference standard of computed tomographic myelography for evaluation of dogs with intervertebral disc disease. Vet Surg 2011; 41: 207–214.

29. Bibevski JD, Dave MR, Henrickson TD, Axlund TW. A prospective evaluation of CT in acutely paraparetic chondrodystrophic dogs. J Am Anim Hosp 2013; 49: 363–369.

30. Dennison SE, Drees R, Rylander H, Yandell BS, Milovancev M, Pettigrew R, Schwarz T. Evaluation of different computed tomography techniques and myelography for the diagnosis of acute canine myelopathy. Vet Radiol Ultrasoun 2010; 51: 254–258.

31. Schulz KS, Walker M, Moon M, Waldron D, Slater M, McDonald DE. Correlation of clinical, radiographic, and surgical localization of intervertebral disc extrusion in small-breed dogs: a prospective study of 50 cases. Vet Surg 1998; 27: 105–111.