RESEARCH ARTICLE

Distinguishing Neurological Signs of Vestibular Dysfunction in Dogs: Central Vs. Peripheral Vestibular Disease

Rajat Sagare[1]*, Gowri Balakrishnan [1], Kirubakaran Jeyaraja[1], Arun Arunprasad[2], Namakal Rajamanickam Senthil[3]

Abstract

The present study was carried out at Madras Veterinary College Teaching Hospital on dogs (n=28) presented with head tilt, nystagmus, and strabismus, suggestive of vestibular disease. The standard neurologic examination was performed, which consisted of an evaluation of mental status (level of consciousness), gait and body posture, postural reactions, and cranial nerve examination. These animals underwent various diagnostic tests and were classified as peripheral vestibular disease (PVD, n=14) and central vestibular disease (CVD, n=14). Seventeen dogs (60.1%) out of 28 dogs irrespective of the group showed gait abnormalities such as veering or leaning, falling, circling, non-ambulatory tetra paresis, hypermetria, and wide-based stance. Among those dogs ambulatory tetra paresis was seen more with CVD dogs and leaning/ veering was observed more in PVD dogs. Six dogs out of 28 dogs showed cranial nerve dysfunction irrespective of PVD or CVD with cranial V and IX dysfunction in CVD dogs. Spontaneous resting nystagmus was observed in 21 dogs out of 28 dogs while a higher percentage of horizontal nystagmus was observed in PVD dogs and vertical nystagmus was observed in CVD dogs. There were no significant differences between groups regarding prevalences of abnormalities of segmental spinal reflexes, spinal hyperpathia, alterations in muscle tone, muscle atrophy, and alterations in the cutaneous trunci reflex. Results of the present study suggested that the neurologic examination, in its entirety, allowed reliable localization of peripheral versus central neurologic dysfunction across interpreters, but no individual feature of the neurological examination bore a strong relationship to the location of the lesion.

Key words: Central vestibular, Dogs, Neurological, Nystagmus, Peripheral vestibular, Strabismus.

Ind J Vet Sci and Biotech (2024): 10.48165/ijvsbt.20.5.26

Introduction

The vestibular system is responsible for preserving the proper spatial orientation of the eyes, head, trunk, and limbs with the gravitational field of the earth, even when there are changes in linear or rotational acceleration or tilting (Rossmeisl, 2010). Disorders affecting the vestibular system can lead to a range of balance issues and irregularities in the positioning of the head, neck, body, and eyes. Typical clinical indicators of vestibular system dysfunction comprise vestibular ataxia, stumbling, circular movement, rolling, head tilting, and nystagmus (LeCouteur, 2003). When assessing a patient with vestibular system dysfunction, the foremost objective for a clinician is to differentiate between central vestibular disease (CVD) and peripheral vestibular disease (PVD). This is crucial because the potential diagnoses, diagnostic approaches, treatment strategies, and prognoses vary significantly between the two conditions (Troxel *et al.,* 2005).

Accurately diagnosing CVD necessitates recognizing clinical indicators that cannot be attributed to peripheral vestibular system disorders. Clinical signs frequently associated with CVD encompass vertical nystagmus, changing direction of nystagmus, deficits in multiple cranial nerves, cerebellar dysfunction, altered consciousness, spinal ataxia, paresis, and impaired postural reactions (Thomas, 2000; Boudreau *et al.,* 2018). This study aimed to investigate the prevalence of signs indicating vestibular system dysfunction in dogs diagnosed with either central or peripheral vestibular disease as well as to distinguish neurological signs of central vs. peripheral vestibular dysfunction in dogs.

[1]Department of Veterinary Clinical Medicine, Madras Veterinary College, TANUVAS, Chennai-600 007, Tamil Nadu, India

[2]Department of Veterinary Surgery and Radiology, Madras Veterinary College, TANUVAS, Chennai-600 007, Tamil Nadu, India

[3]Centralized Clinical Laboratory, Madras Veterinary College, TANUVAS, Chennai-600 007, Tamil Nadu, India

Corresponding Author: Rajat Sagare, Ph.D. Scholar, Department of Veterinary Clinical Medicine, Madras Veterinary College, TANUVAS, Chennai-600 007, Tamil Nadu, India. e-mail: rajat.sagare@gmail.com

How to cite this article: Sagare, R., Balakrishnan, G., Jeyaraja, K., Arunprasad, A., & Senthil, N. R. (2024). Distinguishing Neurological Signs of Vestibular Dysfunction in Dogs: Central vs. Peripheral Vestibular Disease. Ind J Vet Sci and Biotech. 20(5), 134-137.

Source of support: Nil

Conflict of interest: None

Submitted 26/3/2024 **Accepted** 28/04/2024 **Published** 10/09/2024

Materials and Methods

Dogs (n=28) presented to Madras Veterinary College Teaching Hospital, Chennai, with clinical signs such as head tilt, nystagmus, strabismus, and vestibular ataxia

were taken as subject to study. The standard neurologic examination consisted of evaluation of mental status (level of consciousness), gait and body posture, postural reactions (conscious proprioception, hopping, wheelbarrowing, extensor postural thrust, hemi-standing or hemi-walking, and visual and tactile placing [small dogs]), cranial nerve function, and segmental spinal reflexes (patellar, cranial tibial, gastrocnemius, perineal, triceps brachii, biceps brachii, and extensor carpi radialis). Other parameters that were evaluated included degree of muscle tone, presence of muscle atrophy, presence of signs of discomfort or pain during vertebral palpation, and cutaneous trunci reflex. Specific to the vestibular system, the presence and direction of head tilt, strabismus, and nystagmus were documented.

Dogs were classified as having central vestibular disease (CVD) or peripheral vestibular disease (PVD) based on clinical criteria adapted from the method described by de Lahunta (1983). Fourteen dogs were classified as having PVD since they had signs of dysfunction of the peripheral vestibular system, including loss of balance, vestibular ataxia, head tilt, horizontal or rotary nystagmus, and positional strabismus, while other 14 dogs were classified as having CVD for signs, in addition to signs listed for dogs with PVD, such as signs of dysfunction of brain stem or cerebellar structures adjacent to the vestibular nuclei. These signs included altered mental status, spinal ataxia, dysmetria, upper motor neuron paresis, postural reaction deficits, intention tremors, and dysfunction of any cranial nerve other than cranial nerve VII.

Disease of the central vestibular system was confirmed in 14 dogs by means of computed tomography (CT), CSF analysis, and PCR analysis. The disease of the peripheral vestibular system was confirmed in 14 other dogs by means of CT, otoscopy (myringotomy), skull radiography, thyroid hormone analysis, or because clinical signs resolved without medical intervention within 14 days (suggestive of idiopathic vestibular disease).

Statistical analysis of collected data was performed with GraphPad Prism 8.4 software (GraphPad Software, CA, USA). Descriptive statistics such as percentages were used while the data was analyzed using the Chi-square (and Fisher exact test) test. For all comparisons, a value of $p<0.05$ was considered significant.

Results and Discussion

In the present study, a total of 28 dogs presented vestibular signs. Among them 14 dogs had CVD and 14 dogs had PVD. These animals underwent neurological examination which was divided into visual signs (mental status, gait, body posture), postural reactions, and cranial nerve examination. In the present study out of 14 dogs with CVD, 4 dogs (28%) showed signs such as dull or depression, and one (7%) was characterized as stuporous, while dogs with PVD were normal and active based on mental status. The level of consciousness is controlled by the ascending reticular activating system located in the brain stem (de Lahunta, 1983). Thus, dogs with CVD may have altered consciousness (*i.e,* stupor, coma, or signs of depression), whereas dogs with PVD should be alert and appropriate to their surroundings (de Lahunta 1983; LeCouteur, 1999, 2003; Troxel *et al.,* 2005; Boudreau *et al.,* 2018).

In the present study, 17 dogs (60.1%) out of 28 dogs irrespective of the group showed gait abnormalities such as veering or leaning, falling, circling, non-ambulatory tetra paresis, hypermetria, and wide-based stance. There were no significant differences between groups (CVD vs PVD) regarding these gait abnormalities.Results of the present study suggest that the prevalences of certain specific signs of vestibular system dysfunction differ between dogs with CVD and dogs with PVD. Dogs with CVD showed a higher percentage of signs such as non-ambulatory tetra paresis (21.42%), rolling (14.29%), and hypermetria (7.14%) than dogs with PVD; while dogs diagnosed with PVD showed a higher percentage of signs such as veering or leaning to one side (35.71%) and wide-based stance or gait (21.42%)(Table 1). The lack of a significant difference between groups was likely a result of the small patient population in the study. Previous reports (de Lahunta, 1983; LeCouteur, 1999, 2003; Troxel *et al.,* 2005; Boudreau *et al.,* 2018) have suggested that there is little difference in gait between dogs with CVD and dogs with PVD, with the exception that dogs with CVD may have cerebellar ataxia (eg, hypermetria), upper motor neuron paresis, or

Table 1: Gait abnormalities detected in 14 dogs with central vestibular disease (CVD) and 14 dogs with peripheral vestibular disease (PVD)

Gait abnormality	Central Vestibular Disease n (%)	Peripheral Vestibular Disease n (%)	P value
Veering/Leaning	2 (14.29%)	5 (35.71%)	0.385
Falling	4 (28.57%)	4 (28.57%)	0.999
Rolling	2 (14.29%)	1 (7.14%)	0.999
Circling	3 (21.42%)	3 (21.42%)	0.999
Non-ambulatory tetraparesis	3 (21.42%)	0	0.222
Hypermetria	1 (7.14%)	0	0.999
Wide-based stance or gait	1 (7.14%)	3 (21.42%)	0.5956

proprioceptive ataxia as these signs are observed most often in animals with cerebellar disease (de Lahunta, 1983).

A head tilt was observed in all 28 (100 %) dogs irrespective of PVD or CVD. There was no difference in percentages of dogs with a head tilt between dogs with CVD and dogs with PVD which is in accordance with previous reports (de Lahunta, 1983, 1999; LeCouteur, 2003; Troxel *et al.,* 2005; Boudreau *et al.,* 2018). The direction of the head tilt was associated with the side on which the lesion was suspected to be located at the time of initial examination. This was not unexpected because it has previously been reported that the head tilt should be toward the side of the lesion (Troxel *et al.*, 2005; Garosi *et al.,* 2012). In the present study, the direction of head tilt was not associated with side on which the lesion was located, as determined by means of advanced imaging. This is likely explained by the presence of bilateral or multifocal disease in many dogs

In the present study, 6 (21.42%) dogs out of 28 dogs showed cranial nerve dysfunction irrespective of PVD or CVD. There were no significant differences between groups (CVD vs PVD) regarding cranial nerve dysfunction (Cranial nerve V, VII and IX). Dogs with CVD showed a higher percentage of cranial nerve dysfunction V (14.29%), and IX (7.14%) than dogs with PVD (Table 2). One dog with CVD showed cranial nerve IX dysfunction, which had signs of decreased gag reflex and dysphagia. Dysfunction of cranial nerves other than cranial nerves VII and VIII has been cited (LeCouteur, 1999; LeCouteur, 2003; Troxel *et al.,* 2005; Rossmeisl, 2010; Boudreau *et al.,* 2018) as an indication that an animal has CVD. The probable reason for these nerve dysfunctions can be the neuroanatomic relationship between central vestibular structures and the origin of cranial nerves V through XII. However, there was no significant difference between groups regarding prevalence of dysfunction of cranial nerves V and VII, and none of the dogs in either group had evidence of dysfunction of cranial nerves VI, X, XI, and XII. The lack of a significant difference between groups was likely a result of the small patient population in the study.

Normal physiologic nystagmus was observed in all directions of head movement in 25 (89.2%) out of 28 dogs. There was no significant difference between groups but there was higher percentage of physiological nystagmus noticed in PVD (92.85%) when compared to CVD (85.71%). Spontaneous resting nystagmus was observed in 21 (75%) dogs out of 28 dogs. There was no significant difference in the dogs with spontaneous resting nystagmus between the CVD and PVD groups, but there was a higher percentage of physiological nystagmus noticed in PVD (92.85%) when compared to CVD (57.14%)(Table 3). No significant differences were observed between groups in regard to the type of nystagmus (*i.e.,* horizontal, rotary, or vertical) or the change from resting to positional nystagmus (eg, resting rotary nystagmus that changed to positional vertical nystagmus). In the present study, there was no significant difference between groups, but a higher percentage of vertical nystagmus was noticed in CVD (42.85%) when compared to PVD (7.14%), while there was no significant difference between groups but a higher percentage of horizontal nystagmus was noticed in PVD (50%) when compared to CVD (28.57%)(Table 3). Previous reports by de Lahunta (1983), LeCouteur (1999, 2003), and Troxel *et al.* (2005) have suggested that horizontal or rotary nystagmus can be observed in dogs with either CVD or PVD, but that vertical nystagmus is observed only in dogs with CVD.

Table 2: Cranial nerve dysfunction detected in 14 dogs with central vestibular disease (CVD) and 14 dogs with peripheral vestibular disease (PVD).

Cranial nerve	Central Vestibular Disease	Peripheral Vestibular Disease	P value
V (Trigeminal)	2 (14.29%)	0	0.4815
VI (Abducent)	0	0	NA
VII (Facial)	2 (14.29%)	2 (14.29%)	0.999
IX (Glossopharyngeal)	1 (7.14%)	0	0.999
X (Vagus)	0	0	NA
XI (Accessory)	0	0	NA
XII (Hypoglossal)	0	0	NA

NA- Not applicable

Table 3: Nystagmus detected in 14 dogs with central vestibular disease (CVD) and 14 dogs with peripheral vestibular disease (PVD).

Nystagmus	Central Vestibular Disease	Peripheral Vestibular Disease	P value
Normal physiologic nystagmus	12 (85.71%)	13 (92.85%)	0.999
Spontaneous resting nystagmus	8 (57.14%)	13 (92.85%)	0.768
Horizontal nystagmus	4 (28.57%)	7 (50%)	0.445
Rotatory nystagmus	1 (7.14%)	4 (28.57%)	0.325
Vertical nystagmus	6 (42.85%)	1 (7.14%)	0.073

In the present study, positional ventral strabismus was observed in 23 (82.5%) dogs. There was no significant difference between groups with regard to the prevalence of ventral strabismus (CVD, n=11, 78.57%; PVD, n=12, 85.71%). Rossmeisl (2010) and Boudreau *et al*. (2018) stated that this positional ventral strabismus is frequently observed in dogs with CVD or PVD. This may be attributed to the fact that several dogs had bilateral disease in the present study; as a result, there was an insufficient number of dogs with unilateral disease to compare the eye demonstrating positional ventral strabismus and lesion location.

In the present study, there were no significant differences between groups in regard to prevalences of abnormalities of segmental spinal reflexes, spinal hyperpathia, alterations in muscle tone, muscle atrophy, or alterations in the cutaneous trunci reflex. Furthermore, there was no significant difference between groups, but higher percentage of proprioceptive deficits was noticed in CVD (21.42%) when compared to PVD (7.14%). Postural reaction deficits are seen because of direct or indirect involvement of proprioceptive or upper motor neuron pathways traversing the brainstem (LeCouteur, 1999; LeCouteur, 2003; Troxel *et al.,* 2005; Rossmeisl, 2010).

Conclusion

Overall, results of the present study suggested that the neurologic examination, in its entirety, allowed reliable localization of peripheral versus central neurologic dysfunction across interpreters, but no individual feature of the neurologic examination bore a strong relationship to the location of lesion (peripheral or central).

Acknowledgement

Authors thank the Head of Department of Veterinary Clinical Medicine and Dean of the Madras Veterinary College and University TANUVAS authorities for clinical facilities provided.

References

Boudreau, C.E., Dominguez, C.E., Levine, J.M., Mankin, J., Anderson, K.M., Voges, A.K., & Fosgate, G.T. (2018). Reliability of interpretation of neurologic examination findings for the localization of vestibular dysfunction in dogs. *Journal of American Veterinary Medical Association*, *252*(7), 830-838.

de Lahunta, A. (1983). Vestibular system - special proprioception. In: *Veterinary Neuroanatomy and Clinical Neurology*. 2nd edn., Philadelphia, WB Saunders Co, pp. 238-254.

Garosi, L.S., Lowrie, M.L., & Swinbourne, N.F. (2012). Neurological manifestations of ear disease in dogs and cats. *Veterinary Clinics of North America: Small Animal Practice, 42,* 1143-1160.

LeCouteur, R.A. (1999). Feline vestibular disorders. Part I: Anatomy and clinical signs. *Journal of Feline Medicine & Surgery, 1,* 71-80.

LeCouteur, R.A. (2003). Feline vestibular diseases – new developments. *Journal of Feline Medicine & Surgery, 5,* 101-108.

Rossmeisl, J.H Jr. (2010). Vestibular disease in dogs and cats. *Veterinary Clinics of North America: Small Animal Practice, 40*, 81-100.

Thomas, W.B. (2000). Vestibular dysfunction. *Veterinary Clinics of North America: Small Animal Practice, 30,* 227-249.

Troxel, M.T., Drobatz, K.J., & Vite, C.H. (2005). Signs of neurologic dysfunction in dogs with central versus peripheral vestibular disease. *Journal of American Veterinary Medical Association*, *227,* 570-574