Scientific Works. Series C. Veterinary Medicine. Vol. LXIV (2), 2018
ISSN 2065-1295; ISSN 2343-9394 (CD-ROM); ISSN 2067-3663 (Online); ISSN-L 2065-1295

A REVIEW OF NEUROLOGICAL EXAMINATION-DIFFERENTIAL DIAGNOSIS FOR INTRACRANIAL DISEASES IN CATS AND DOGS

Raluca Mihaela TURBATU, Cristina FERNOAGA, Nicolae TUDOR, Constantin VLAGIOIU

Faculty of Veterinary Medicine, Department of Clinical Sciences,
105 Splaiul Independentei, 105, Bucharest, Romania

Corresponding author email: ralucza@yahoo.com

Abstract

This review paper aimed to gather together the most relevant findings concerning the neurological examination and the localization of the lesion in the central nervous system. Clinical signs are specific depending on the regions of the brain involved (forebrain, brain stem, cerebellum or vestibular apparatus). In order to obtain and correlate these signs to a certain localization of the lesion, it is necessary that some steps be strictly followed when examining the animal. The first step is to obtain the full medical history of the patient by discussing with the owner. The physician must then perform the physical examination, followed by a complete and correct neurological examination. Neurological signs can be associated to a certain region of the brain. The mental status is evaluated first, followed by the behavior and the way the animal interacts with the environment, the postural reactions (head, body, limbs) and the gait, cranial nerves, proprioception, spinal reflexes, panniculus and perineal reflexes. When the examination is complete, all findings are taken into consideration and an accurate neuroanatomic diagnosis is established.

Key words*: neuroanatomic diagnosis, forebrain, brain stem, cerebellum, vestibular system.*

INTRODUCTION

In our country, although veterinary neurology is at a starting point, the number of patients with neurological deficits is increasing. Considering this situation, study and interpretation of the available scientific articles is essential in order to develop new clinical skills and to adjust the neurological examination protocol so it can suit our cases.

In order to establish an accurate etiological diagnosis, proper interpretation of neurological deficits and precise neuroanatomical localization are essential.

Diseases that affect one of the four regions of the brain (forebrain, brain stem, cerebellum or vestibular apparatus) are accompanied by a set of clinical features that are specific to each one of them. For the clinicians, the real challenge is to make a differential diagnosis between a systemic, orthopaedic, cardiovascular and neurological disease.

Sometimes clinical signs can indicate a lesion that affects the nervous system, but the etiological diagnosis requires a series of additional investigations in order to be established. In that case, an anatomic diagnosis helps the physician choose the most sensitive investigations for the suspected area.

This review briefly discusses the steps that have to be followed in order to localize an intracranial nervous system lesion.

MATERIALS AND METHOD

In order to make a selection of the most relevant articles for the debated subject, we searched in the veterinary scientific databases Pubmed and ScienceDirect using the keywords: neurologic examination, intracranial lesions, brain disease, vestibular disease. Considering the fact that veterinary neurology is a field that has developed especially in the last decades, the written articles on this subject are fewer compared to other areas. We have found about 40 articles, from which we have selected those who were written later than 2009. The provided information was compared with the information available in the reference books of neurology. The common points and differences which have resulted from this analysis are presented in the following sections.

RESULTS AND DISCUSSIONS

The neurologic examination is preceded by anamnesis and a complete and correct physical examination.

The anamnesis is a very important part of the evaluation and should include signalment of the patient and chief concern (the reason why the owner is presenting the pet to the veterinarian).
Patient's age, breed and sex are factors that helps the clinician focus on a certain pathology. For example, congenital or development diseases occur in the young, whereas neoplasia and degenerative disorders are more common in older patients (Thomas, 2010).
The onset, evolution and course of the illness are parameters that can lead to the etiologic diagnosis. The onset should be defined as peracute to acute (over minutes to hours), subacute (onset over days), chronic (onset over several days, weeks or months) or episodic (animal return to normal in between episodes). Inflammatory and metabolic disorders are diseases that progress over several days, while tumors and degenerative diseases have a slowly progressive course.
Current therapy which includes prescribed or nonprescription drugs is also an important factor that should be taken into consideration before the anamnesis is being finished.
Other general information that can be helpful for the diagnosis are vaccination status, diet, previous travel history, drug reactions and the animal's environment, including the potential for toxin exposure (Platt & Garosi, 2012).
The physical examination include examination of the respiratory movements, pulse, body temperature, coat and skin, mucous membrane, peripheral lymph nodes and other notable abnormalities. Carefully following these steps, the veterinarian can exclude a systemic illness that affects the nervous system, such as fever associated with meningoencephalitis, otitis in patients with vestibular syndrome (Rijnberk & van Sluijs, 2008).
The first step of the neurological examination is based on observation, as there is a lot of important information that can be gathered only this way. Using the observation, the clinician should asses the mentation, behavior, posture and the gait. Then, a hands-on neurological examination should be undertaken. That includes: postural reactions, spinal reflexes, sensory testing (superficial and deep pain),
cranial nerve examination. The order in which the different parts of the examination are completed is mainly determined by the degree of cooperation of the patient, which usually improves as the examination progresses.
Trying to perform the examination in spite of strong resistance by the patient makes both the observation and their interpretation difficult.
It is better to start the examination with the procedures that are least likely to upset the patient and delay the painful tests until the end of the examination (Adams & Brown, 2009).

Mental status and behavior

When abnormal, mentation can be a sign of forebrain or brain stem dysfunction.
Normal consciousness implies wakefulness and awareness of the environment and is asses by observing for appropriate or inappropriate response to the environment. The following levels of consciousness can be distinguished:
- alert- normal response to environmental stimuli;
- disoriented/confused- abnormal response to environment;
- depressed/obtundent- less responsive to environment;
- stuporous- unconscious but can be roused by painful stimuli;
- comatose- unconscious and unresponsive to any (including painful) stimuli. (Packer, 2013)
Common behavior abnormalities in patients with brain disease include disruptions in the pet's normal sleep-wake cycle, restlessness, aimless pacing or wandering, getting stuck in corners, the tendency to turn and cycle to one side, decreased or abnormal interaction with the family, aggression, loss of learnt behavior and excessive vocalization (Thomas, 2010).

Posture

Normal posture is characterized by symmetrical and equal bearing of weigh by all limbs, together with symmetrical positioning of the head, neck, trunk, and tail as appropriate for the breed.
Searching for postural abnormalities can be very useful as they provide important information for lesion localization. The abnormalities that can be found in the head posture are head tilt, head turn, dorsal and ventral flexion. Head tilt implies rotation of the median plane of the head, with one ear lower than the other and it indicates vestibular dysfunction (DeLahunta & Glass, 2010). With head turn or

torticollis, the head is perpendicular to the ground, but nose is turned to one side. Head turn is a sig of forebrain disease.
Decerebrate rigidity is associated with a rostral brain stem lesion and is characterized by extension of all limbs and opistotonus and implies a comatose mental status.
Decerebellate rigidity is specific for acute cerebellar lesion and is characterized by opistotonus, thoracic limbs extension, flexion of the pelvic limbs and normal mental status.
Schiff-Sherrington posture consists of extension of the thoracic limbs and paralysis of the pelvic limbs and is associated with an acute thoracic or lumbar spinal cord lesion (Platt & Olby, 2012).

Evaluation of the gait and other abnormal movements

A normal gate requires intact function of the brainstem, cerebellum, spinal cord and sensory and motor peripheral nerves, neuromuscular junctions and muscles.
Evaluation of the gait should be done with the aim of determining if the animal is ataxic, paretic or lame and which limbs are involved (Platt & Garosi, 2012).
Ataxia is an inability to perform normal, coordinated motor activity that is not caused by weakness, musculoskeletal abnormality, or abnormal movements such as tremor or myoclonus. Ataxia can evolve with hypermetria or hypometria. The 3 types of ataxia are sensory, cerebellar and vestibular.
Sensory ataxia is caused by a lesion affecting the general prioprioceptive pathways in the peripheral nerve, dorsal root, spinal cord, brain stem or forebrain. The loss of the sense of limb and body position causes clumsiness and incoordination, resulting in a wide-based stance and a swaying gait.
Cerebellar ataxia is cause by the cerebellar dysfunction and is accompanied by hypermetria and an overreaching, high stepping gait.
Vestibular ataxia is cause by a lesion of the vestibular system. Is characterized by leaning, veering, stumbling, falling, and in severe affected individuals, rolling to the affected side. The animal may stand with a broad base and exhibit exaggerated extensor tone of the contralateral limbs, accompanied by a decrease of tone in the ipsilateral limbs (Kent et al., 2010).
Paralysis is a complete loss of the motor function, whereas paresis indicates a partial loss of motor function. Based on whether a lesion affects the UMN or LMN system, two types of paresis can be distinguished: UMN paresis and LMN paresis.
UMN paresis is characterised by normal or exaggerated myotatic reflexes, and spasticity. Spasticity predominates in the antigravity muscles, and results in a stilted gait characterised by decreased limb flexion during protraction.
LMN paresis is characterised by a short-strided gait that may mimic lameness, tendency to collapse, trembling, hopping and ventral neck flexion.
Lameness is usually associated with pain from orthopaedic disease. Additionally, it can be associated with nervous system dysfunction referred to as nerve root signature (referred pain down a limb causing lameness or elevation of the limb, resulting from entrapment of the spinal nerve, usually due to a lateralized disc extrusion
or nerve root tumour). (Adams & Brown, 2009)
Abnormal movements include: tremors, myoclonus, myotonia and abnormal muscle tonus.
Tremor can be localized to one region of the body or can be generalised. A terminal tremor (intention tremor) occurs as the body parts nears a target during goal-oriented movements. Head tremor is specific for cerebellar disorders and happens when the patient tries to eat, drink or sniff an object.
A generalised postural tremor is seen in dogs with steroid-responsive tremor syndrome, intoxications or metabolic disorders.
Myotonia is a delayed relaxation of muscle following voluntary contraction. It may occur with some congenital and acquired myopathies and the percussion of a myotonic muscle often results in a dimple" appearance.
Myoclonus is a brief, shock like contraction of skeletal muscle. Encephalomyelitis caused by canine distemper is the most common cause of abnormal myoclonus in dogs. Other inflammatory diseases of the nervous system that can cause myoclonus are granulomatous meningoencephalomyelitis, bacterial encephalitis, protozoal encephalitis or steroid-responsive meningitis-arteritis.

Muscle tone may be abnormal in spinal cord injury. Muscle hypotonicity occurs when LMN lesions are present. Muscle hypertonicity or spasticity are characteristic for UMN lesions (Thomas, 2010) (Lorenz et al., 2010).

Postural reactions

Postural reactions assess the same pathways involves in gait and are useful in making a differential diagnosis between orthopaedic and neurologic disorders. The proprioceptive tests are: proprioceptive positioning, hopping, wheelbarrowing, visual placing and tactile placing, hemiwalking and hemistanding.

Proprioceptive positioning implies turning over the paw so the dorsal surface be in contact with the ground. The animal should immediately return the paw to a normal position. This test evaluates proprioception in the proximal region of the limb. A delayed or absent response indicates neurological disease.

For hopping, the animal is supported under the abdomen and allowed to weigh bear on one leg and is then moved laterally. This test is sensitive for subtle weakness or asymmetry.

Wheelbarrowing implies supporting the animal's hindquarters and walk him forwards, with the head's raised. The normal response is that the animal has to walk on the thoracic limbs without scuffing or stumbling. This test is used in order to identify any lesions that affect the thoracic limbs.

The tactile placing is tested by covering the patient's eyes and move it toward the edge of the table. When the paw touches the table, the animal should immediately place the limb forward to rest the paw on the table surface. The thoracic and the pelvic limbs are tested, and the left and right side are compared.

Visual placing is tested similarly, except that the patient's eyes are not covered. With this test, each eye can be evaluated individually by covering the contralateral eye, and the temporal and nasal visual fields can be evaluated by approaching the table from the side of the patient.

Hemiwalking can be performed by holding up the limbs on one side of the body and moving the patient laterally. Normal animals will hop on the limbs while keeping the foots under their body for support (Platt & Olby, 2012).

Spinal reflexes

Following gait and postural reactions testing, the clinician should be able to narrow down the lesion localization as being cranial to T3 spinal cord segments, caudal to T3 spinal cord segments or within the peripheral nervous system (peripheral nerve, neuromuscular junction or muscles).

Spinal reflexes evaluation helps to narrow down further the lesion localization by testing the integrity of the C6-T2 and L4-S3 intumescences, as well as the respective segmental sensory and motor nerves (LMN) that form the peripheral nerves and the muscles innervated (Platt & Garosi, 2012).

Clinically, there are a number of reflexes that can be evaluated in the animal: Extensor carpi radialis reflex, thoracic limb flexion reflex, patellar reflex, pelvic limb flexion reflex, perineal and panniculus reflex.

Myotatic reflexes are graded with regard to force of contraction, speed of contraction, and length or range of motion, using the following scale: 0-absent, 1-reduced, 2-normal, 3-exaggerated, 4-markedly exaggerated with clonus.

Weak or absent reflexes can occur with lesions that affect any part of the reflex arc, severe rigidity or muscle contraction that limits joints movement or the state of spinal shock, which can occur immediately after severe spinal cord injury.

Causes of exaggerated reflexes are lesions in the UMN pathways cranial to the spinal segment involved in the reflex or a lesion of the L6-S1 spinal segments or sciatic nerve that can cause an exaggerated patellar reflex. Exaggerated reflexes can be found in anxious or excited patients.

For the perineal reflex, a gentle stimulation is applied to the perineal area with the tip of forceps. A normal response is contraction of the anal sphincter. An absent or depressed response indicates a lesion in the sacral spinal cord or pudendal nerve.

For panniculus reflex, a pinprick stimulus is applied to the skin at the level of L5 and subsequently moved cranially. A normal response is bilateral contraction of the cutaneous trunci muscle. An absent reflex suggests a lesion slightly cranial to the point of stimulation so this test is most useful to narrow

down thoracolumbar spinal cord injuries (Dewey & da Costa, 2015).

Sensory testing

The purpose of testing pain perception is to detect and map out any areas of sensory loss. This testing aids anatomic localization and determination of prognosis.

Superficial pain sensation is tested by pinching the skin between the digits, while deep pain sensation is tested by pinching across the bone of the digit or tail.

Two types of response may be seen: a reflex flexion of the limb or skin twitch, indicating that the sensory neurons and spinal segments are intact and a behavioural response, such as crying or biting which indicates that the ascending pain pathways in the spinal cord and brain stem to the forebrain are intact.

Lack of deep pain sensation is a poor prognostic indicator of severe spinal cord injuries, because the fibres for deep pain sensation are the most resistant to injury. If deep pain sensation is lost, all spinal cord function is lost (Thomas, 2010).

Cranial nerves

There are 12 pairs of cranial nerves. Each has a different role in controlling the different functions of muscles or gland within the head. There are a series of tests that can be used to assess different combination of nerves, like menace response, pupillary light reflex, palpebral reflex, corneal reflex, response to nasal stimulation, oculovestibular reflex, gag reflex.

Cranial nerve I is tested if the owner is concerned about the animal loss of smell. The olfactory nerve is tested with a small morsel of canned food. The normal response implies a sniffing behaviour, although the patient can't see the food. The loss of smell is uncommonly recognised and is caused in general by nasal disease, rather than brain disease.

Cranial nerve II requires more than one test in order to be asses. The important tests are cotton balls dropping, menace response and pupillary light reflex. The visual following is asses by dropping cotton balls and observing if the patient's eyes and head are following the object. The menace response implies moving the hand toward the animal's eye in a threating way and observing a blink response.

The pupillary light reflex is tested with a bright light. The response should be pupillary light constriction. Blindness with normal pupils indicates a lesion of the forebrain, diencephalon, optic radiation or occipital cortex.

Cranial nerves III, IV and VI subserve eye movements and are tested together. The veterinarian should observe spontaneous eye movement when the patient looks about and then move the patient's head to induce physiological nystagmus.

Pathological nystagmus can be observed when the head is at rest or in a neutral position (spontaneous nystagmus) or when the head is moved into certain positions (positional nystagmus). Pathologic nystagmus results form a unilateral disturbance in the normal bilaterally tonic influences provided by vestibular neurons to the motor nuclei of the extraocular muscles (Rossmeisl, 2010).

The corneal sensation is tested by touching the cornea. The normal response is blink and globe retraction. Resting pupil size should be evaluated. If anisocoria is present, the doctor must determine which pupil is abnormal. Causes of an abnormally small pupil are uveitis or a painful corneal condition. Causes of an abnormally large pupil with normal vision are iris atrophy, dysautonomia or lesions of the oculomotor nerve or its nucleus in the brainstem.

Cranial nerve V provides sensory innervation to the face and motor innervation to the muscles of mastication. The 3 branches should be tested separately. The ophthalmic branch is tested by touching the medial cantus of the eye and expect for a blink response. The maxillary branch is tested touching the upper lip, lateral to the canine tooth. The normal response is wrinkling of the face and a blink. The mandibular branch is tested by touch the lower lip.

Cranial nerve VII should be asses by observing the patient's face for asymmetric eyelid closure, spontaneous blinking or a drooping ear. The facial nerve also mediated tearing, which is evaluated with Schirmer test.

Cranial nerve VIII is responsible for hearing and vestibular function. The test should include a loud noise to which the alert patient should respond orientating the head and ears toward the noise. Other signs of the nerve deficiency

include same symptoms as the vestibular syndrome.

Cranial nerves IX and X are tested together because they supply motor and sensory innervation to the pharynx. The effect of the test should be pharyngeal contraction after touching it. Also, the doctor should ask for any signs of dysphagia, voice change or inspiratory stridor.

Cranial nerve XI supplies motor innervation to the trapezius muscle and its function is difficult to be evaluated.

Cranial nerve XII innervates the muscles of the tongue. Any sign of atrophy, asymmetry or deviation of the tongue should be assessed. Also, the patient should be observed when is drinking water (Platt & Olby, 2012) (Lorenz et. al., 2010).

Intracranial lesion localization

After performing the neurological examination, all the findings have to be corelated in order to establish if the patient suffers from a neurologic disease and to localize the lesion.

For the **forebrain**, characteristic signs include alterated mental status with depression or disorientation, contralateral blindness with normal pupillary light reflex, abnormal movements like ipsilateral circling, head turn, head pressing, low postural responses in contralateral limbs. Abnormal behavior and seizures are highly predictable for forebrain lesions.

Most animals with **brainstem** lesions present abnormal mental status with depression, stupor or coma, paresis of all or contralateral limbs, several cranial nerve deficits, possibly decerebrate rigidity, accompanied by respiretory or cardiac abnormalities. Gait deficits vary from mild, ipsilateral hemiparesis to tetraplegia with normal to exaggerated spinal reflexes.

Patients with **cerebellar** lesions will present with generalized ataxia, intention tremor of head and eye and a truncal sway. A typical sign for cerebellar lesion is hypermetria. There should be no changes in mentation or behavior at all. Acute cerebellar lesions can induce decerebellate rigidity (Platt & Garosi, 2012) (Packer, 2013).

Diseases of the **vestibular system** cause varyingly severe balance and postural disturbance along with vestibular ataxia. Clinical signs may be a result of dysfunction of the peripheral or central components of the vestibular apparatus, as shown in table 1.

Peripheral vestibular disease does not affect strength or general proprioception. Spontaneous or positional horizontal or rotatory nystagmus can occur, and the fast phase will be away from the side of the lesion. Peripheral vestibular lesions can also affect the facial nerve and postganglionic sympathetic innervation to the head (Horner syndrome).

Vestibular signs associated with a depressed level of consciousness, spastic hemiparesis, cranial nerve V-XII deficits, or general proprioceptive deficits on the same side as the vestibular deficits should be considered to indicate a central vestibular disorder (Rossmeisl, 2010) (DeLahunta & Glass, 2010).

Table 1- Differentiating clinical features of peripheral and central vestibular disease (Rossmeisl, 2010)

Clinical sign	Peripheral vestibular lesion	Central vestibular lesion
Head tilt	Toward lesion	To either side
Pathologic nystagmus	Direction not altered by head position Horizontal or rotatory Fast phase away from lesion	Direction may change with head position Horizontal, rotatory or vertical
Postural reactions	Normal	Deficits ipsilateral to lesion
Conscious proprioception	Normal	Deficits ipsilateral to lesion
Cranial nerve deficits	±ipsilateral CN VII	±CNN V-XII ipsilateral to lesion
Horner syndrome	±postganglionic	±preganglionic (rare)
Consciousness	Normal Disoriented if acute	Normal to comatose

CONCLUSIONS

In order to obtain an accurate neuroanatomic diagnosis, stages of the neurological examination must be strictly followed.

All findings – normal or abnormal- should be taken into consideration for a precise localization of a lesion.

Each of the four regions of the brain is characterised by a specific series of clinical signs. The most important elements that have to be asses in order to establish a differential diagnosis are the mental status, the behaviour, the gait, the proprioception, the cranial nerves and spinal reflexes.

Revealing and interpretation of these signs is the key for a correct intracranial lesion localisation.

REFERENCES

Adams R.D., Brown R.H., 2009. Approach to the patient with neurologic disease, Principles of Neurology, 8th Edition, New York, 3-10.

DeLahunta A., Glass E., 2010. Vestibular system: special proprioception. Veterinary neuroanatomy and clinical neurology,3rd Edition, Saunders Elsevier, Riverport Lane, St. Louis, 319-347.

Dewey C.W., da Costa R.C, 2015. Practical guide to feline and canine neurology, 3rd edition,Wiley Blackwell, Iowa, United State, Chap. 3, 29-45.

Kent M., Platt S.R., Schatzberg S.J., 2010. The neurology of balance: Function and dysfunction of the vestibular system in dogs and cats. Vet.J , 185(3):247-258.

Lorenz M.D., Coastes J., Kent M., 2010. Handbook of veterinary neurology, 5th Edition. Saunders, Elsevier, Riverport Lane, St. Louis, Chap 1, 16-35.

Packer. A. R., 2013. Small animal neurological examination, iBooks, Chap.2, 20-22.

Platt S., Garosi L., 2012. Small animal neurological emergencies, Manson publishing, London, Chap. 1, 16-24.

Platt S., Olby N., 2013. BSAVA Manual of canine and feline neurology, 4th Edition. British small animal veterinary association, Gloucester, Chap. 1, 9-24.

Rijnberk A., van Sluijs F.J., 2008. Medical History and Physical Examination in Companion Animals, Saunders Elsevier, Riverport Lane, St. Louis, Chap 18, 170-174.

Rossmeisl J.H. Jr., 2010. Vestibular disease in dogs and cats. Vet Clinic North America Small Animal practice, 40 (1):81-100.

Thomas W.B., 2010. Evaluation of veterinary patients with brain disease. Vet Clinic North America Small Animal practice, 40 (1):1-19.

Thomson C.E., Hahn C., 2012. Veterinary neuro-anatomy: a clinical approach, Saunders Elsevier, Riverport Lane, St. Louis, Chap. 13, 134-136.

ANIMAL PRODUCTION, PUBLIC HEALTH AND FOOD QUALITY CONTROL