

**Anjop J. Venker-van Haagen**  
**Ear, Nose, Throat, and Tracheobronchial Diseases in Dogs and Cats**



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Anjop J. Venker-van Haagen, DVM, PhD, DECVS  
Former Associate Professor of Veterinary Ear Nose and Throat Diseases  
Faculty of Veterinary Medicine  
Department of Clinical Sciences of Companion Animals  
Utrecht University, The Netherlands

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E-mail: [info@schluetersche.de](mailto:info@schluetersche.de)

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## Abbreviations

ADC	Analog-to-digital converter	kHz	Kilohertz
B.O.S.	Brachycephalic obstructive syndrome	MRI	Magnetic resonance imaging
BAER	Brain stem auditory evoked response	Nd-YAG laser	Laser using Yttrium-Aluminum-Garnet with Nd ions
BERA	Brain stem evoked response audiometry	NSAIDs	Nonsteroidal anti-inflammatory drugs
CPG	Central pattern generator	NTS	Nucleus tractus solitarius
CRDs	Complex repetitive discharges	$p < 0.01$	The probability that the result is due to chance is less than 1 in 100 (highly significant)
CT	Computed tomography	P generation	Parent generation
DAC	Digital-to-analog converter	SLN	Superior laryngeal nerve/Cranial laryngeal nerve
dB SPL	Decibel sound pressure level	T-tube	T-shaped tracheal tube
ECG	Electrocardiogram	V	Trigeminal nerve
EEG	Electroencephalogram	VII	Facial nerve
EMG	Electromyogram/Electromyography	IX	Glossopharyngeal nerve
F generations	Offspring generations	X	Vagus nerve
FISH and RH mapping	Methods for gene mapping used for association studies	Xph	Pharyngeal branch of the vagus nerve
Hz	Hertz	XII	Hypoglossal nerve
i.d.	Inside diameter		
Ig	Immunoglobulin		

## Preface

Among my fellow members of the International Veterinary Ear Nose and Throat Association (IVENTA), the reason for marking out specialization in diseases of the ear, nose, throat, and tracheobronchial tree is clear. They recognize that many of the diseases of these organs have similar clinical signs, similar infectious etiology, or similar regulatory mechanisms, and that these organs share cranial nerves for the execution of their functions.

Most of the knowledge in this field has been provided to veterinarians—and regularly updated by—the major textbooks of small animal internal medicine and small animal surgery. The textbook presented here aims not only to provide a more complete overview of diseases of the ear, nose, throat, and tracheobronchial tree but also to increase understanding of the functions of the respective organs for hearing, olfaction, swallowing, vocalization, and conditioning inspired air for gas exchange in the lung.

Each chapter begins with functional considerations of its subject and ends with a clinical topic chosen for its uncommon complexity. The book is readily accessible through a detailed list of contents and an elaborate index. It is

intended to provide information of interest to academics as well as practitioners and students.

I am grateful to Dr. Bruce Belshaw for editing the English language with care and experience. Mr. Joop Fama handled the figures and made them shine, and I am grateful both for his knowledge and for the time and care he gave to the work. Dr. Ulrike Oslage at Schlütersche Verlagsgesellschaft invited me to write this textbook and I thank her not only for the opportunity but also for the free hand which I had in preparing it. Dr. Simone Bellair at Schlütersche Verlagsgesellschaft fine-tuned the written material and the various pictures into a book and I am grateful for her professional skill.

I hope that readers will find this a pleasant and useful book and that interest in this field will continue to develop the science of ear, nose, throat, and tracheobronchial diseases in dogs and cats.

Utrecht, May 2005

Anjop Venker-van Haagen



*Cat, China, second half of the 18th century. Cat shows signs of severe dyspnea: mouth breathing and fear. (From: Rijksmuseum, Diary 1999, week 44, with permission).*



## 1 The Ear

### 1.1 Functional considerations

#### 1.1.1 The ear as sensory organ

The ear is a sensory organ that has evolved to receive and transform the air waves or vibrations that we call sound into a code of neural impulses to be conveyed to the brain. The resulting distinct patterns of neural activity in the brain are then integrated with information from other sensory systems to guide behavior.<sup>52</sup> The first stage of this transformation occurs in the external and middle ear, which collect sound waves and amplify their pressure, so that the sound energy can be successfully transmitted from air to the fluid that fills the cochlea of the inner ear. In the inner ear the signal is divided into simpler, sinusoidal components, with the result that the frequency, amplitude, and phase of the original signal are faithfully converted by the sensory hair cells into encoded electrical activity in the auditory nerve fibers.<sup>52</sup> In the brain the earliest stage of central processing occurs in the cochlear nucleus, where the peripheral auditory information diverges into a number of parallel central pathways. These include the superior olivary complex, where the information from the two ears interacts to aid in localizing the sound in space. The cochlear nucleus also projects to the inferior colliculus of the midbrain, a major integrative center and the first place where auditory information can interact with the motor system. The inferior colliculus is an obligatory relay for information traveling to the thalamus and cortex, where more complex aspects of sound are processed.<sup>52</sup>

**External ear.** The external ear is the portion lateral to the tympanic membrane. It consists of the external auditory canal and its cartilaginous extension, the auricle. The medial part of the auditory canal is surrounded and supported by

the temporal bone. The auricle is covered with skin which continues as the lining of the auditory canal. This skin is thin and in the medial part of the auditory canal it has little subcutaneous tissue, but in the lateral part it bears numerous hair follicles and ceruminous and sebaceous glands. Both the bony and the cartilaginous parts of the auditory canal provide an open passageway for air to the tympanic membrane. The tympanic membrane is the medial boundary of the auditory canal and its lateral component is formed by the epithelium of the skin lining the auditory canal. In mammals the auricle and the auditory canal are together regarded as a simple funnel that collects and crudely filters sound. In humans, however, the auricle and auditory canal increase the acoustic pressure at the tympanic membrane of sounds in the 1.5 kHz to 5 kHz range, which is the frequency range most important for speech perception.<sup>37</sup> In the dog and cat the auricle can be turned toward the source of sound; right and left auricles can move independently so that each ear can focus on separate sounds. Hence the animal does not have to turn its head to localize sounds, as humans do. It is not clear to what extent the shape of the auricle—large and erect like that of the German shepherd or folded like that of the cocker spaniel—influences hearing capacity, but the latter might seem to be disadvantageous, at least in theory.

**Tympanic membrane.** The tympanic membrane terminates the ear canal and covers the entrance to the tympanic cavity, thereby separating the external from the middle ear. The membrane is composed of three layers, the outer squamous cell epithelial layer being a continuation of the epithelial layer of the skin of the external ear canal, the inner mucosal layer being a continuation of the mucosa of the middle ear or tympanic cavity, and the intervening fibrous layer or tunica propria. The tympanic membrane is thin, slightly oval, semitransparent, and concave, owing to traction on its

medial side by the tensor tympani muscle. There are three ossicles (malleus, incus, stapes) in the middle ear, the manubrium of the malleus being fixed in the tunica propria of the tympanic membrane. The tensing of the tympanic membrane makes it ideal for the conversion of sound waves into vibrations of the malleus.

### 1.1.2. Middle ear matches different impedances

The major function of the middle ear is to match relatively low impedance airborne sounds to the higher impedance fluid of the middle ear. The term impedance in this context stands for a medium's resistance to movement. Because of the difference in impedance of the two media, 99.9% of the sound energy is reflected at the interface between air and fluid and only 0.1% is converted into pressure changes in the fluid. The middle ear overcomes this problem and ensures transmission of the sound energy across the air-fluid boundary. The first and major boost is achieved by focusing the force impinging on the relatively large diameter tympanic membrane onto the much smaller diameter membrane of the oval window, where the stapes, the last of the three ossicles, is attached and where the vibration of the tympanic membrane is conveyed to the fluid of the inner ear. A second and related process involves the mechanical advantage gained by the lever action of the three interconnected ossicles which link the tympanic membrane to the oval window.<sup>47, 52</sup>

**Auditory ossicles.** These are also attached to the wall of the epitympanum or dorsal part of the tympanic cavity by several ligaments. While the manubrium of the malleus is embedded in the tympanic membrane, the head is suspended in the epitympanum and is fused with the incus in a rigid joint. The long process of the

incus is then linked to the stapes by another joint, one that is rigid in the direction of the piston-like movement of the stapes but flexible perpendicular to this movement. The stapes is suspended in the oval window of the cochlea by two ligaments. The stapedius muscle—the smallest striated muscle in the body—is attached to the head of the stapes. It pulls the stapes in a direction perpendicular to the piston-like motion and is innervated by the facial nerve. The other muscle of the ossicles is the tensor tympani muscle attached to the muscular process of the malleus. It pulls the manubrium of the malleus inward, tensing the tympanic membrane. This muscle is innervated by the trigeminal nerve. One of the functions of the two muscles of the middle ear is to support and stiffen the ossicular chain. In addition, because loud sounds are attenuated by the actions of the acoustic reflex—the contraction of both muscles in response to loud sounds—it is likely that another function of the reflex is to protect the inner ear from damage due to overexposure to excessive sounds. In addition to their protective function, the two muscles may attenuate low-frequency masking sounds that might otherwise interfere with auditory function. Contraction of the muscles during chewing would attenuate the associated sounds, which are largely low frequency, while preserving sensitivity to high-frequency external sounds.<sup>37, 47</sup>

**Tympanic cavity.** The ventral part of the tympanic cavity forms the tympanic bulla. Although its function is not known with certainty, it may be to improve the perception of sounds of very high and very low frequencies.<sup>17</sup> The middle part of the tympanic cavity, the mesotympanum, includes the tympanic membrane in its lateral wall and opens rostrally into the nasopharynx via the auditory (eustachian) tube. The auditory tube is short and its narrow lumen is compressed laterally and usually not open. The tube is confined by an inverted cartilaginous trough except along its ventral border.

The pharyngeal openings of the left and right auditory tubes are located in the lateral walls of the nasopharynx and are marked by accumulations of lymphoid tissue. The cartilage of the auditory tube extends into the medial wall of the pharyngeal opening and stiffens it. The auditory tubes facilitate equalization of the pressures on the opposite sides of the tympanic membrane. They open temporarily during each swallow and yawn. This permits escape of the slight secretion from the goblet cells and the glands in the lining of the tympanic cavity.<sup>17</sup>

**Inner ear.** The inner ear is housed in a bony labyrinth in the petrous portion of the temporal bone. It contains the membranous labyrinth with its sensory organs of hearing and balance. The membranous labyrinth consists of an interconnecting series of epithelial-lined tubes and spaces containing endolymph. There are three functionally-related parts: (1) the semicircular ducts, containing hair cells that detect acceleration of the endolymph caused by rotation of the head; (2) the utricle and saccule, containing hair cells with a membrane, the macula, that responds to linear acceleration of the head and its static position; and (3) the cochlear duct, which is the auditory portion of the labyrinth, resembling a snail shell and containing the hair cells involved in hearing, in the organ of Corti.

**Cochlea.** This is the bony shell surrounding the cochlear duct in a spiral of  $3\frac{1}{4}$  turns (in the dog) around a hollow central core of bone, the modiolus, which contains the cochlear nerve. The osseous spiral lamina that winds around the modiolus, much like the thread of a screw, divides the lumen of the cochlea into the tympanic and vestibular canals, both containing perilymph. The osseous spiral lamina begins within the vestibule, the ovoid space that communicates with the cochlea rostrally and with the semicircular canals caudally, and ends at the apex. The vestibular canal communicates with the vestibule and hence the fluid within,

the perilymph, is acted upon by the foot plate of the stapes resting on the membrane in the oval window. The round window is the opening, also covered by a membrane, by which the tympanic canal communicates with the middle ear. Both windows are at the basal end of the cochlea. The membranous cochlear duct completes the separation of the two canals but they communicate at the apex of the modiolus via a small opening, the helicotrema. Perilymph gains access from the subarachnoid space to the vestibule, cochlea, and semicircular ducts via the perilymphatic duct.<sup>19</sup>

### 1.1.3 Organ of Corti, sensory organ for hearing

The organ of Corti in the cochlear duct is the sensory organ for hearing. It contains many different cells, of which the hair cells are the most directly involved with hearing. The hair cells, so-called because of the hair-like bundles of cilia that project from their apex, are arranged in rows along the basilar membrane, the connective tissue that forms the floor of the cochlear duct. There are two main types of hair cells, outer and inner. The outer hair cells—about 12,000 in the human cochlea—are arranged in 3 to 5 rows along the basilar membrane, while the inner hair cells—about 3,500 in the human cochlea—are arranged in a single row. The outer hair cells are cylindrical and the inner hair cells are shaped like a flask or pear. The outer hair cells are incompletely surrounded by supporting cells (Deiter's cells on the basilar membrane side and Hensen's cells laterally) and they lie free in the perilymph covering the organ of Corti. The inner hair cells are tightly surrounded by supporting cells. The stereocilia of the outer hair cells form an inverted »W« and a basal body representing a rudimentary cilium (kinocilium). The inner hair cells have stereocilia arranged linearly and also a rudimentary cilium.<sup>21, 47</sup>

**Stereocilia/hair cells.** These are linked together by specific structures. The tips of the tallest outer hair cell stereocilia are embedded in the overlying tectorial membrane, whereas the tips of the inner hair cell stereocilia are free of the membrane. The tectorial membrane is anchored medially at the limbus, medial to the cochlear duct, and laterally to Hensen's cells by a fibrous net. The basilar membrane is attached to the modiulus at a different site and when the basilar membrane and the tectorial membrane are displaced vertically by the traveling wave created by sound energy delivered to the oval window, the displacement of the basilar membrane creates a shearing action between the cuticular plate, the base of the stereocilia, and the tectorial membrane. The stereocilia of the outer hair cells which are attached to both structures bend. The streaming movement of the fluid between the cuticular plate and the tectorial membrane may bend the inner hair cell cilia which are not attached to the tectorial membrane.<sup>37</sup> It is the bending of the stereocilia which initiates the electrical current in the hair cells and the formation of the electrical potential in the fibers of the cochlear nerve.

The resting potential of the hair cell is between  $-45$  mV and  $-60$  mV relative to the fluid that bathes the basal end of the cell. At the resting potential, only a small fraction of the potassium-selective transduction channels at the tip of the stereocilia are open. When the hair bundle is displaced in the direction of the tallest stereocilium, more transduction channels open, causing depolarization as  $K^+$  enters the cell. Depolarization in turn opens voltage-gated calcium channels in the hair cell membrane, and the resultant  $Ca^{2+}$  influx causes more transmitter release from the basal end of the cell into the auditory nerve endings. Because some of the transduction channels are open at rest, the receptor potential is biphasic: movement toward the tallest stereocilia depolarizes the cell, while movement in the opposite direction leads to hyperpolarization. This

allows the hair cell to generate a sinusoidal receptor potential in response to a sinusoidal stimulus.<sup>52</sup>

The basal and apical surfaces of hair cells are separated by tight junctions. The apical end with stereocilia is exposed to the potassium-rich, sodium-poor endolymph produced by the stria vascularis. The basal end is bathed in perilymph, the same fluid that fills the tympanic canal, and is  $K^+$ -poor and  $Na^+$ -rich. The endolymph is about 80 mV more positive than the perilymph, while the inside of the hair cell is about 45 mV more negative than the perilymph. The resulting electrical gradient across the membrane of the stereocilia (about 125 mV) drives  $K^+$  through the open transduction channels into the hair cell.<sup>52</sup>

It is the inner hair cells that are the sensory receptors and 95 % of the fibers in the auditory nerve that project to the brain arise from this subpopulation. The terminations of the outer hair cells are almost all from axons that descend from cells in the brain. The outer hair cells have a function in changing the stiffness of the tectorial membrane by actively contracting and relaxing. In this way the outer hair cells sharpen the frequency-resolving power of the cochlea at particular locations, and thereby account for the cochlea's extreme sensitivity.<sup>52</sup> The basilar membrane is stiffer at the basal end than at the apex. The gradual change in stiffness causes sounds reaching the ear to create a wave on the basilar membrane that travels from the base toward the apex of the cochlea. This traveling motion is the basis for the frequency separation that the basilar membrane provides, higher frequencies activating sensory cells at the base of the cochlea and lower frequencies activating the sensory cells at the apex. The outer hair cells interact actively with the motion of the basilar membrane.

#### 1.1.4 Ascending and descending pathways for hearing

The auditory nervous system contains an ascending and a descending pathway. The ascending auditory nerve extends from the organ of Corti to the cochlear nucleus in the brain stem and its bipolar cell bodies are in the spiral ganglion, located in the modiolar region of the cochlea. Fibers cross over from the cochlear nucleus to the contralateral superior olivary complex and from there the bundle continues as the lateral lemniscus before ascending to the inferior colliculus, in which most of its fibers terminate. The bilateral inferior colliculi are connected by commissural fibers and fibers also project to the medial geniculate body. From the medial geniculate body fibers project to the primary auditory cortex.<sup>48, 49</sup> Of the two descending pathways, the corticocochlear system connects the primary auditory cortex with the inferior colliculus and the periolivary nucleus, while the olivocochlear system connects these pontine nuclei with hair cells of, mainly, the contralateral cochlea, as described in the cat.<sup>27</sup>

#### 1.1.5 Vestibular organ, the key to postural reflexes and eye movement

The vestibular organ and the cochlea are joined and the common membranous labyrinth that forms the auditory cochlea also comprises the utricle, the sacculus, and the semicircular canals of the vestibular organ. The vestibular membranous labyrinth within the osseous labyrinth is filled with endolymph. Like the cochlear endolymph, it is high in  $K^+$  and low in  $Na^+$ . The space between the osseous labyrinth and the membranous labyrinth is filled with perilymph, similar in composition to that in the vestibular and tympanic canals of the cochlea, low in  $K^+$  and high in  $Na^+$ . As in the cochlea, the cell bodies of the vestibular hair cells are

embedded in perilymph and their stereocilia are in endolymph. Depolarization of these cells is similar to that of the cochlear hair cells (see above). Movement of the endolymph in the direction toward the tallest stereocilium causing an influx of  $K^+$  via the top of the stereocilia, which in turn opens the voltage-gated calcium channels. The calcium influx causes more release of transmitter from the basal end of the cell. Movement away from the tallest stereocilium causes hyperpolarization of the hair cell and thus reduces nerve transmission. The vestibular hair cells are located in the utricle and the sacculus and in the three ampullae at the base of the semicircular canals.<sup>53</sup>

**Vestibular hair cells.** These hair cells provide the basis for vestibular function. The hair bundles have a specific orientation in each part of the vestibular organ. The accelerating movement of the endolymph in the semicircular canals causes the cap of the ampullary crest, the organ consisting of hair cells and their supporting cells, to bend following the movement of the fluid. Sensory receptors in the macule of the saccule and the utricle consist of hair cells and associated supporting cells. Overlying the hair cells is the otolithic membrane, in which crystals are embedded. A shearing motion between the macule and the otolithic membrane occurs when the head undergoes linear acceleration.

Vestibular function is a key component in both postural reflexes and eye movements. Damage to the system affects balance, the control of eye movements when the head is moving, and the sense of orientation in space. The dysfunction of the vestibular system will be illustrated in the section on ototoxicity.

## 1.2 History and clinical signs

### 1.2.1 History

The medical history in diseases of the ear is characterized less by hearing disorders than by pain. Pain can be caused by disease of both the external ear and the middle ear, and can be unilateral or bilateral. When the inner ear is involved in the dog or the cat, vestibular dysfunction is more commonly mentioned in the history than loss of hearing. Diseases of the ear are usually presented as disorders affecting one or both ears exclusively. However, questioning may reveal signs of a more generalized skin disorder of which inflammation of the external ear is a part, or recurrent periods of fever and other signs of infection together with middle ear disease, or other signs of neurogenic disease rather than a vestibular problem alone. It is therefore essential that additional questions be asked about the animal's general condition, appetite, drinking, and physical activity; whether there have been changes in its

habits; and whether there have been similar problems in the past, in either or both ears. The onset of ear problems may be sudden or gradual. The onset of signs caused by a foreign body in the external ear is often sudden and recognized by the owner. In contrast, inflammation of the external ear often begins gradually but becomes progressively worse; with such a history it is useful to ask what treatments have been tried. There are many ways of »treating« inflammation of the external ear which cause the inflammation to persist or even to increase. If parasitic infection is suspected, questions should be asked about contacts with other animals, of the same or different species.<sup>79</sup> Vestibular dysfunction is usually sudden in onset and the signs are usually dramatic, but hearing loss may go unnoticed, especially if unrelated to a specific event. In some cases of sudden deafness an associated event is mentioned by the owner, but it is not always easy to find a logical relation between this and the hearing loss. Unilateral hearing loss is often masked by normal hearing in the other ear.

*Figure 1.1 a–c:*  
This cocker spaniel was shaking its head continuously. Its ear canals were clean and not inflamed. (a) The auricles are long but were normal on visual inspection. (b) Palpation of the auricles revealed several heavy lumps of hair with accumulated dirt and food. (c) Clipping away the hair stopped the shaking.



### 1.2.2 Clinical signs

**Pain** is an »unpleasant sensory and emotional experience associated with actual or potential tissue damage«. <sup>1, 44</sup> It is a complex subjective experience, depending on the severity of the noxious damage, but also on a variety of additional cognitive and emotional aspects, and is therefore difficult to measure. It is even more complicated when a dog or cat is in apparent pain as described by the owner or caretaker. Ear pain is usually recognized if the animal tries to prevent handling of the ear, is less alert than usual, and sometimes very carefully scratches the ear or shakes the head. Pain and pruritus are not easily distinguished by casual observation, and in dogs and cats the signs of both can be suppressed by analgesic drugs. Pain caused by external ear disease may be severe and may change the dog's or cat's behavior, something often better recognized in retrospect when the pain disappears with successful treatment.



**Signs of external ear disease.** These are predominantly pain and pruritus, the pain sometimes causing the dog to turn its head slightly with the painful ear downwards. In dogs the auricle may be in an uncharacteristic position for the breed, and in cats it may be folded and turned backwards. The concave side of the auricle is usually thinly haired and inflammation of the external ear can be recognized by swelling and lesions of the skin, often with excess cerumen and exudate. Long hair on the auricle can become heavy with accumulated dirt and food, also causing the dog to shake its head in the absence of ear inflammation (Figure 1.1 a–c). Rubbing or scratching of the ear which injures the skin can lead to bacterial infection, increasing the inflammation and pain. Other signs of inflammation include scaling, hyperpigmentation, and tissue proliferation, the latter particularly at the base of the auricle on the concave side and around the entrance to the ear canal. Thickening of the auricle can result from acute or chronic dermatitis or perichondritis. The auricle can also be extremely thickened by a hematoma within the cartilage layer, presenting as a bulge on the concave side. In contrast to an abscess, which occurs most often in cats, a hematoma does not result in pain or general malaise.

**Temperature of the auricle.** The temperature of the auricle varies with the flow of blood, best appreciated on the concave side by the accompanying variation in its pink color. The color can vary not only with the ambient temperature but also with the balance between sympathetic and parasympathetic influence on blood flow in the auricle. A »red and warm« auricle may be a normal and transient finding, and is then usually bilateral.

**Cerumen,** or ear wax, is formed on the concave side of the base of the auricle and in the external ear canal. It is a mixture of the secretions of the sebaceous and the ceruminous glands. It has a waxy consistency and varies in color from



*Figure 1.2:*  
An English pointer with signs of acute left-sided labyrinthitis: rotation of the head and cranial portion of the body, with the affected ear down and the eyes turned toward the affected side also.

yellow to brown. The secretion of the sebaceous glands being gray to white and that of the ceruminous glands being brown, the color of cerumen varies with the relative contribution of each. A thin layer of cerumen is normally present in the areas where the glands are located and sometimes small lumps are found at the base of the auricle at the entrance to the ear canal. The odor of cerumen is usually described as aromatic, but if the skin of the base of the auricle and the ear canal is inflamed, the production of cerumen can be increased and its



*Figure 1.3:*  
A cocker spaniel, 3 months after ototoxic injury to the labyrinth of the right ear. The dog could stand and walk, but the rotation of its head was permanent.

composition can be changed. An increase and alteration in the bacterial flora can change the appearance of the cerumen and give it a more penetrating odor.<sup>79</sup> When combined with pus and detritus, its appearance and odor may become overwhelming and repulsive.

Primary inflammatory disease of the middle ear mainly causes pain. It is usually unilateral and appears to be severe. The animal shuns petting of its head and loses alertness and appetite. Hearing loss is to be expected but is almost never mentioned by the owner. If the inflammation is purulent and the tympanic membrane is ruptured, there can be purulent discharge from the external ear canal.

**Vestibular dysfunction** is most apparent when it is unilateral. The signs of acute vestibular labyrinthitis are loss of equilibrium, inability to stand or walk, and falling to the affected side when trying to stand; rotation of the head and cranial portion of the body with the affected ear down; deviation of the eyes toward the affected side (Figure 1.2); and horizontal nystagmus with the rapid phase toward the unaffected side. The animal is severely disoriented, nauseated, and refuses food. The vestibular system responds immediately with central compensatory mechanisms (a process of neuroplasticity), sensory substitution (vision and proprioception), and learning processes. Within 3 days the nystagmus disappears, within a week the animal can stand with assistance, and within 3 weeks it can walk. The head rotation is usually permanent (Figure 1.3), but can be masked by compensation so that it is only observed when the animal's interest is absorbed by an event. Although the vestibular dysfunction is permanent, the persisting clinical signs vary according to the progress of compensation. However, those disabilities still present at 3 months will remain. In this regard, the clinical history may be helpful in determining the time of onset of the vestibular dysfunction if it is reviewed with an appreciation of the effects of compensatory mechanisms.

### 1.2.3 Physical examination

The auricles are inspected for symmetry and uniformity, and for abnormalities of the skin and hair. They are palpated to discover temperature differences and structural changes. They may be cooler than normal as a result of poor circulation, as in shock, or warmer because of hyperemia associated with inflammation. Structural changes can be due to tumor or ossification, which is a common reaction of the auricular cartilage to trauma. The entrance to the ear canal is inspected to evaluate its width. Normally the outer part of the canal, which is subcutaneous, is wide enough to be inspected without instruments. Both the medial part turning toward the temporal bone and the part within the temporal bone can only be inspected with an otoscope. The outer part is vertical when the animal's head is positioned to look straight ahead and is thus termed the vertical part, while simultaneously the medial part is horizontal and is therefore termed the horizontal part of the ear canal.<sup>79</sup> The external ear canal can be examined by palpation. The tip of the auricle is taken by one hand and stretched laterally while the first three fingers of the other hand are curved around the outermost part of the ear canal and then the tips of the fingers explore the cartilage medially. Pain elicited by this indicates inflammation. The lumen of the canal can be checked by softly compressing the cartilage. Proliferation of the lining increases the width of the canal and prevents it from being compressed. The cartilage can become ossified in chronic inflammation, resulting in a palpably hard and rigid tube. This is a painful disease, as the procedure will reveal.<sup>79</sup> A tumor that is invisible to inspection can be presumed (but not diagnosed) if there is a palpable local increase in the diameter of the ear canal. Special diagnostic techniques are required for examination of the parts of the ear inside the temporal bone.

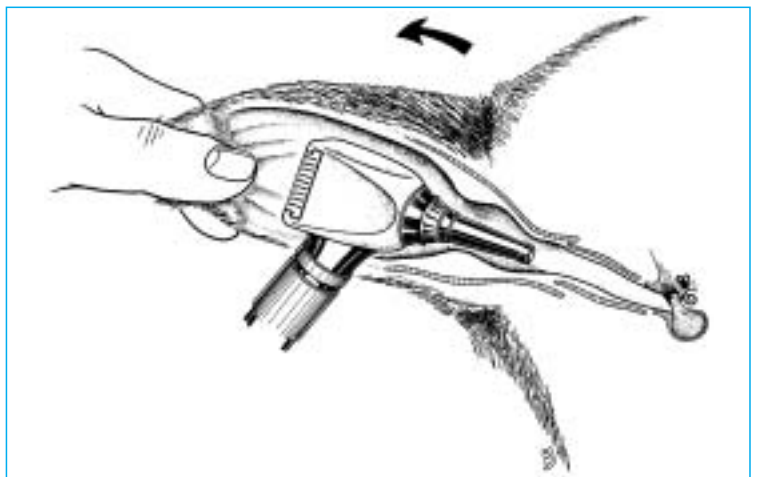


*Figure 1.4: Otoscope with a rechargeable battery, an ear speculum with interchangeable cones (various sizes available), and a magnifying lens. This model has glass fibers incorporated in the wall of the speculum, transmitting a bright circle of light at its tip.*

### 1.3 Special diagnostic techniques

Inspection of the external ear canal is very important in diagnosis of diseases affecting it. The entrance can be inspected with the naked eye but the remainder of the canal can only be inspected with the help of special illumination techniques and instruments. An otoscope is used for this purpose in the dog and the cat. This instrument consists of an ear speculum with interchangeable cones of several sizes, a small light source, and a magnifying lens (Figure 1.4). The best otoscopes have glass fibers incorporated in the wall of the speculum which transmit a bright circle of light at the tip while

*Figure 1.5: Otoscopic examination. The left hand of the examiner grasps the right auricle firmly, pulling it out laterally and ventrally. This brings the vertical and horizontal parts of the ear canal into line, forming a straight, horizontal tube. The otoscope is held in the right hand and as it is inserted into the ear canal, the examiner looks through the magnifying lens.*



keeping the light source out of the visual path. By choosing the appropriate size of cone for each, the same otoscope can be used to examine the ear canal and tympanic membrane in a small cat as well as a very large dog.

### 1.3.1 Otoscopic examination

The technique of otoscopic examination is the same in the dog and cat. The animal is held on the examination table in a sitting position or resting on its sternum, restrained by an expert assistant. Its head is held looking straight ahead. If possible, its mouth should not be tied closed during this examination, particularly with something passing behind the ears, for this usually presses the ear canal shut, or fixes it tightly against the head. When the animal is held securely, either sitting or lying on its sternum, the left hand (if the examiner is right-handed) is used to grasp the auricle securely and pull it out firmly, laterally and ventrally. This brings the vertical and horizontal parts of the ear canal into line, to form a straight, horizontal tube (Figure 1.5). The otoscope is then taken in the right hand, and while looking through the otoscope, so that everything is carried out under visual control, the examiner carefully inserts the otoscope into the ear canal. The oto-

scope should not be advanced unless the lumen of the ear canal is clearly in view. Bringing it into view is accomplished by moving the stretched auricle and with it the ear canal, first dorsally, then rostrally, ventrally, and caudally, while looking through the otoscope. Hence the ear canal and the otoscope are moved together and in alignment rather than moving the otoscope within the ear canal. This allows the entire canal and the tympanic membrane to be inspected with the least possible discomfort for the animal. The skin lining the ear canal is very sensitive and hence pressing upon it with the otoscope should be avoided.

*Examination of the ear canal* of dogs is occasionally hindered by excessive hair in the entrance. The hair can be plucked in bunches with a short jerk, using a round-tipped Péan forceps. It is not noticeably painful for the animal and scarcely results in hyperemia of the skin of the ear canal. If there is excessive scaling or cerumen or exudate, the ear canal must be flushed before a satisfactory otoscopic examination can be carried out. If microscopic examination for parasites or bacteriological examination of exudate is indicated, material must be collected for this purpose before flushing. Water or 0.9% NaCl solution can be used to flush the ear. The fluid must have a temperature of 35 to 39 °C in order to prevent dizziness and even a shock-like reaction. The stream of water must be thin and forceful in order to wash out the long and narrow ear canal. The canal should be stretched out as described for otoscopy, so that the vertical and horizontal parts form a straight tube. An apparatus developed for ear flushing in humans is excellent for use in dogs and cats. It consists of a small heater in which tap water is brought to body temperature and held there (Figure 1.6). The water is sprayed into the ear through a short cannula at the pressure in the water supply pipe. The strength of the stream can be regulated by a lever on the handle but is limited to a physiologically

*Figure 1.6:*  
An apparatus developed for ear flushing. It consists of a small heater in which tap water is warmed to body temperature and held there. The water is sprayed into the ear canal through a short cannula, at the pressure indicated on the display.



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