INTRODUCTION

Diseases of the middle and inner ear, such as otitis media/interna, are common in domestic rabbits (Oryctolagus cuniculi), guinea pigs (Cavia porcellus), rats (Rattus norvegicus), and other exotic companion mammals. Otitis media/interna is the most common cause of peripheral vestibular disease in exotic mammals. Central neurologic diseases such as encephalitozoonosis in domestic rabbits and pituitary tumors in rats can also result in vestibular signs. It can be challenging to determine if vestibular signs are peripheral or central in origin without diagnostics such as computed tomography (CT) and magnetic resonance imaging (MRI).

CLINICAL PRESENTATION

A detailed history is important in helping build an appropriate differential diagnosis list. A complete physical examination should be performed, including rectal temperature (when appropriate), heart rate and rhythm, and respiratory rate. The presence or absence of upper respiratory disease should be noted. A careful neurologic examination with close attention to cranial nerves and a bilateral aural examination should always be performed on any patient with vestibular signs.¹,² Heavy sedation or general anesthesia may be necessary to allow a complete aural exam, especially in the stressed or painful patient. In rabbits, the external ear canal should be carefully palpated, particularly at its base, where abscesses are commonly found.¹

DIAGNOSTICS

Microbiology and Cytology

Samples of exudates, flushes, and biopsies can be cultured and tested for antibiotic susceptibility and evaluated cytologically. Special stains such as Gram stain can be used when indicated.²
Radiography

Conventional skull radiography can be useful in evaluating the tympanic bullae for evidence of fluid accumulation and bony lysis consistent with middle and inner ear disease. Multiple views, including both oblique views, should be obtained.

Ultrasonography

The middle ear cavity of the rabbit can be visualized ultrasonographically. This technique may be helpful for evaluation of rabbits with confirmed or suspected middle or inner ear disease.

Computed Tomography (CT) and Magnetic Resonance Imaging (MRI)

Computed tomography (CT) is an excellent diagnostic modality for assessment of the middle and inner ears of exotic companion mammals. MRI is excellent at assessing soft tissues and is used less frequently than CT for the evaluation of the ear, but it can be helpful in assessing the brain for diseases that may be associated with vestibular signs such as pituitary tumors.

Endoscopy

Endoscopy can aid in the visualization of the external ear canal and tympanic membrane. Endoscopy can also be used to explore the middle ear cavity during a bulla osteotomy. Samples can be obtained endoscopically for histopathology and microbiology.

RABBITS

Ear Anatomy

The external ear is comprised of the pinna, external auditory meatus, and the external auditory canal. Technically, the ear canal is straight, and there is no horizontal or vertical component. The ear canal is comprised of interlocking auricular cartilages. The proximal segment of cartilage (cartilaginous acoustic meatus, or CAM) is a complete ring and interlocks with the bony acoustic duct arising from the tympanic bulla. The tragus cartilage interdigitates with the CAM in upright-eared rabbits. In lop-eared rabbits, there is a 3- to 5-mm gap between the tragus and the CAM. The tympanic membrane is elliptical in shape and approximately 5.0 mm x 5.75 mm in size.
The rabbit tympanic bulla is very large compared with other species. The width is approximately 11 mm, the height is about 7.5 mm, and the depth is about 5 mm. The bulla is comprised of very thick bone along the lateral and rostral portions. However, the ventral, medial, and caudal portions are quite thin. The facial nerve exits the skull from the stylomastoid foramen and courses along the ventrolateral aspect of the bulla, and should be avoided during surgery at all costs. The inner ear (cochlea and semicircular canals) resides along the dorsomedial aspect of the bulla. Rabbits have a much wider mandible than cats. It is wide along the dorsoventral aspect and has a semicircular mandibular angle that protrudes ventrally. These features make it difficult to palpate the tympanic bulla externally.

Otitis Media/Interna

Otitis media and/or interna is common and likely underreported in rabbits. Otitis media was identified in 20 to 35% of all rabbits on postmortem exam in one study, and in 78 to 80% of rabbits with upper respiratory tract disease. Otitis media/interna can occur secondary to otitis externa or from ascending rhinitis. Lop breeds are prone to otitis externa due to the separation between the tragus and the CAM ventral and folding of the pinna and dorsal section of the cartilaginous vertical ear canal, which results in ear canal stenosis.

Clinical signs of otitis in the rabbit include vestibular signs (nystagmus, ataxia, head tilt, circling), signs of pain (e.g., bruxism, lethargy, anorexia, guarding or hiding), and facial nerve deficits. In many cases, there are no overt clinical signs at all, and diagnosis can be challenging. Otitis is evaluated through history, physical examination, direct visual or endoscopic otoscopy (which may require sedation or anesthesia), and diagnostics such as ear cytology, microbiologic culture and/or staining, and imaging such as conventional radiography, ultrasonography, CT, or MRI.

Medical management with topical and/or systemic antimicrobials can be tried but often fails due to a lack of blood flow to the air- and/or blood-filled tympanic bulla, lack of drainage of debris and pus from the bulla, and/or inappropriate antibiotic use. Systemic antibiotics may improve clinical signs but are rarely effective alone in the resolution of otitis media/interna. Antibiotics should be administered for at least 4 to 6 weeks. Antibiotic selection should be based on results of culture and sensitivity testing when possible. Antibiotics should be selected that penetrate the CNS, such as injectable penicillin (not oral), fluoroquinolones, and potentiated sulfonamides.

Surgical options include bulla osteotomy (BO) and partial or complete ear canal resection (ablation). The ventral bulla osteotomy (VBO) can be performed if infection is limited to the tympanic bulla. However, the ventral surgical approach to the bulla is very challenging and is associated with a high rate of postoperative complications such as cellulitis, abscess formation, and facial paralysis.
The lateral bulla osteotomy (LBO) is an easier approach to the tympanic bulla. The LBO allows debridement of pus and debris and bulla epithelial lining, as well as allowing placement of antibiotic-impregnated polymethylmethacrylate (AIPMMA) beads. For the LBO, the lateral and ventral aspects of the bony external auditory meatus are exposed and removed.\textsuperscript{9} The lateral aspect of the tympanic bulla is then exposed and removed using small rongeurs (e.g., Lempert). The natural opening to the bulla is too small for even the small rongeurs to fit through, and small rongeurs may not be strong enough to remove the thick bone located here. Large rongeurs can be placed into the tympanic opening at an acute angle, but debridement should proceed cautiously, as the ventral wall of the bulla is thin and can shatter easily. If this occurs, the fragments can be manually removed. A pneumatic burr can also be used to enlarge the opening to the bulla.\textsuperscript{9}

Repeated flushing and suctioning are used to debride caseous material and debris as well as the epithelial lining of the bulla, which can also be debrided with a small curette or Volkmann spoon. An endoscope can be inserted into the bulla to confirm that all caseous purulent debris, necrotic tissue, epithelial lining, and bone fragments have been removed. The external canal incision can be left open with distal canal intact and the area surrounding the bulla marsupialized.\textsuperscript{12} Results of LBO with marsupialization were considered acceptable in 87.5\% of cases in one report.\textsuperscript{12}

Bacteria associated with caseous debris has a high rate of recurrence, so placement of AIPMMA beads is often recommended for rabbits. An absorbable gelatin compressed sponge (e.g., Gelfoam) soaked in antibiotic solution can also be used. Ideally, the selection of antibiotics placed within the beads should be based on culture and sensitivity results,\textsuperscript{9} although cefazolin-, amikacin-, or gentamicin-impregnated beads maintained concentrations above MIC for more than 30 days in one study. Ototoxic antimicrobials (e.g., aminoglycosides) are best avoided in the tympanic bulla due to proximity of the inner ear through the oval and round windows. Potential complications are similar to those in other species and include facial nerve paralysis, surgical dehiscence, vestibular dysfunction, hearing deficits, Horner's syndrome, abscission, and fistulation.\textsuperscript{9} Complications are uncommon and usually self-resolving, and can often be prevented with proper surgical technique.\textsuperscript{9}

A partial (PECA) or total (TECA) ear canal ablation should be considered for rabbits with refractory or recurrent otitis externa with or without otitis media and interna. The lateral wall resection (LWR) is no longer advisable since it has been associated with poor outcomes in both rabbits and dogs, as otitis media is common and infected material remains within the tympanic bulla with this surgical approach.\textsuperscript{9} The PECA (partial ear canal ablation) may be indicated if otitis externa is less extensive. Rabbits do not suffer from ceruminous gland hyperplasia and so generally develop less extensive chronic ear canal changes. The PECA preserves the dorsal portion of the vertical ear canal and is more likely to maintain normal ear carriage than the total ear canal ablation (TECA). The PECA may not be as successful in lop breeds, which may be predisposed to recurrence of infection due to persistent postoperative stenosis of the ear canal.\textsuperscript{4,9}
Central Vestibular Disease

By far, the most common disease associated with vestibular signs in rabbits is encephalitozoonosis, or infection with *E. cuniculi*. Other central neurologic diseases that can be associated with vestibular signs in rabbits include infection with human herpesvirus-1 (HHV-1), toxoplasmosis, traumatic brain injury, heat stroke, lead toxicosis, and brain tumors.

RODENTS

Otitis Media/Intern

Infection of the middle ear cavity and inner ear can arise from the external ear canal or from the nasopharynx via the eustachian tube.\(^1\) Otitis media/interna can also be secondary to neoplastic conditions of the external ear canal, such as aural polyps in dwarf hamsters. *Bordetella bronchiseptica, Streptococcus zooepidemicus,* and *Streptococcus pneumonia* are often involved in cases of otitis media/interna in guinea pigs.\(^1\) Facial paralysis and exposure keratitis are common with otitis media/interna in guinea pigs. A careful bilateral auricular examination should be performed when possible, which may require heavy sedation or general anesthesia. Diagnosis may require advanced imaging such as CT and MRI. Treatment options include systemic and topical antibiotics, ideally based on results of culture and sensitivity testing. Azithromycin has been shown to achieve therapeutic concentrations in the middle ear in chinchillas.\(^{13}\) Topical antibiotics are likely only to have efficacy if the tympanic membrane is ruptured. Antibiotic treatment failures are common. Surgery can be considered in certain cases. Total ear canal ablation and pinna amputation were reported in a Russian hamster for treatment of an abscessed ear canal.\(^{14}\) In a separate report, a 1-year-old dwarf hamster underwent ear canal ablation and pinnectomy for treatment of aural squamous cell carcinoma.\(^{15}\) A rat with otitis media/interna was anesthetized and treated with a lateral approach to the ear canal followed by lavage of the middle ear cavity.\(^{16}\) Bulla osteotomy is comparatively easy in the chinchilla due to the enormous size of the tympanic bulla.\(^1\) The chinchilla is often used for experimental studies in otology for this reason. The tympanic bulla is easily accessible through a dorsal approach in the chinchilla.\(^1\)

Central Vestibular Disease

Central neurologic diseases that can be associated with vestibular signs in companion rodent species include pituitary tumors in rats,\(^1\) lead toxicosis, toxoplasmosis, and cerebral larval migrans, among others.

FERRETS
Congenital peripheral vestibular syndrome was reported in a 3-month-old, intact female ferret with a history of ataxia. Brain MRI and a brainstem auditory evoked response test were performed.

Otitis Media/Interna

Otitis media/interna is uncommon in domestic ferrets but does occur. Secondary otitis interna with head tilt, circling, and signs of Horner syndrome has been reported with heavy ear mite infestations (*Otodectes cynotis*) or overzealous ear cleanings. Otitis media can also result from infection with influenza virus in ferrets.

Central Vestibular Disease

Central neurologic diseases that can be associated with vestibular signs in domestic ferrets include infection with canine distemper virus, Aleutian disease, brain tumors such as choroid plexus papilloma, and traumatic brain injury.

References


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