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**Evaluation and review of the aetiology of suppurative destructive otitis media in
dogs.
(Review of literature)**

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Abstract

Otitis media is an inflammation of the middle ear cavity, which includes the tympanum, tympanic bulla, and eustachian tube. Otitis media can be caused by a number of infectious and non-infectious factors. Many cases of otitis media appear to be ignored because an inspection of the external ear canal is sometimes insufficient when otitis externa is visible. Otitis media is often the outcome of chronic otitis externa spreading through a damaged tympanic membrane. In the paper, the aetiological factors, the pathogenesis, the clinical signs, diagnosis, and treatment will be reviewed, as well as patient information from the caseload in 2020 of the Department and Clinic of Internal Medicine of University of Veterinary Medicine, Budapest.

Absztrakt

Az otitis media (középfülgyulladás) a középfül gyulladós megbetegedése, amely magában foglalja a dobhártyát, a dobüreget és az Eustach féle fülkürtöt. A betegség hátterében több fertőző és nem fertőző kórok található. A kórkép sok esetben nincs diagnosztizálva, tekintettel arra, hogy a külső hallójárat gyulladós megbetegedéseinek kétharmadában nem vizsgálható a dobhártya és a dobüreg. Az OM gyakran következménye a külső hallójárat gyulladásának, sok esetben egy sérült dobhártyán keresztüli átfertőződés következményeként. Ebben a munkában a középfülgyulladás kóroktanával, kórfejlődésével, tüneteivel, diagnózisával és kezelésével kapcsolatos szakirodalom összefoglalása mellett az Állatorvostudományi Egyetem 2020-as beteganyagának középfülgyulladós eseteinek a vizsgálata is megtalálható.

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List of abbreviations

OM: otitis media

OE: otitis externa

TM: tympanic membrane

CKCS: Cavalier King Charles Spaniel

Spp: species

PA: Pseudomonas Aeruginosa

VBO: Ventral bulla osteotomy

TECA: Total ear canal ablation

LBO: Lateral bulla osteotomy

CT: computer tomography

MRI: magnetic resonance imaging

PSOM: Primary secretory otitis media

1. Introduction

Otitis is no longer considered to be an isolated condition that affects only the ear canal but rather a syndrome that frequently indicates an underlying dermatological condition. [1] Otitis media (OM) is defined as the inflammation of the middle ear canal and is commonly secondary to acute or chronic otitis externa (OE). [2] OM is also defined as the inflammation of the bulla tympanica, often resulting in the filling of the cavity with exudate that is most commonly thick and dense and can be observed in dogs as well as in cats. [3] Terminologically, otitis generally involves the existence of bacterial, fungal, or parasitic infections as well as allergic reactions, or even due to irritation caused by chemical or mechanical cleaning procedures. Moreover, otitis can also be involved due to the presence of sterile masses such as tumours, inflammatory polyps or even alien materials. [4] OM should be considered when a patient exhibits signs related to neurological conditions affecting the head, such as vestibular disease, Horner's syndrome, or facial nerve injury. [2] OM is commonly camouflaged by the clinical signs of OE and often misled by those of otitis interna, thus OM is not suspected and not diagnosed, except if proper and adequate conclusive methods are carried out. [5] The presence of otitis media in more than half of canine patients with chronic otitis externa should prompt a reconsideration of the cognitive process when confronted with these instances. [2] If left untreated, OM may develop into otitis interna, result in neurological impairment, or create persistent irreversible pathological alterations to the middle and external ears that may only be effectively addressed through surgical intervention. [6] The aim of this review is to have a better understanding of the aetiological factors of OM, more precisely those infections with purulent exudates.

2. Literature review

2.1. The anatomy and physiology of the dog's ear.

The dog's ear is split into three parts: the external, middle, and inner ear. The external ear consists of the pinna and the external auditory canal. [7] The cartilage of the pinna (that is, the auricular cartilage) is a funnel shaped and also forms the basis of the vertical part of the external ear canal. The length of the vertical ear canal is about 2.5cm, and continues into the horizontal ear canal, the basis of which is formed by the annular cartilage. The TM separates the external auditory canal from the middle ear. The TM comprises an epitympanic recess, a large bulla located ventrally, and the proper tympanic bulla proper. The ceruminous glands are situated in the deep dermis layer, under the sebaceous glands and these glands are concentrated in the external ear canal. [8] The TM

has the distinguishing characteristic of being exceptionally thin and tough due to the constant dermal adnexal glands' secretions. Epithelial migration is the principal process by which the TM can remain thin and ensures its self-cleansing abilities. Epithelial migration is the process that involves the centripetal motion of keratinocytes of the ear canal epithelium as well as of the TM along with cerumen and debris away from the TM. [9, 10] The middle ear consists of an air-filled tympanic cavity containing the three auditory ossicles: the malleus, incus, and stapes. [7] The tympanic cavity is linked to the oropharynx by means of the auditory tube (Eustachian tube). The inner ear comprises a membranous and a bony labyrinth which are the organs of balance and hearing purposes. [11]

The three auditory ossicles allow an immediate bony link between the air-filled external environment and the fluid-filled environment of the inner ear's perilymph. [9] The middle ear's primary purpose is the conduction of sound waves which are conducted from the external auditory tube into the air-fluid junction between the middle and inner ear. The ossicles condense the soundwaves that reach the TM to compensate for the alteration in impedance caused by the air-fluid junction between the external and inner ear canal. Hence, the ossicles accommodate an effective way of sound transmission. [12] A minor branch of the facial nerve passes by the TM and exits through the middle ear, thus in case of severe OM or any insult to the dorsal TM, the dog's sense of taste may be impaired since the branch merges with the lingual sensory nerve. [9]

It is worth noting that the tympanic cavity varies according to different breeds whereby a few breeds (Cavalier King Charles spaniel, bulldog) have smaller and flatter cavities compared to the majority of the round and wide appearances in the majority of breeds. [7] Pure breeds with hairy and pendulous pinnae are thought to retain more heat and moisture thus being more prone to suffering from otitis. [8] High risk of otitis in the Cavalier King Charles Spaniel (CKCS) is also thought to be linked to the higher number of compound hair follicles in the horizontal ear canal. [9]

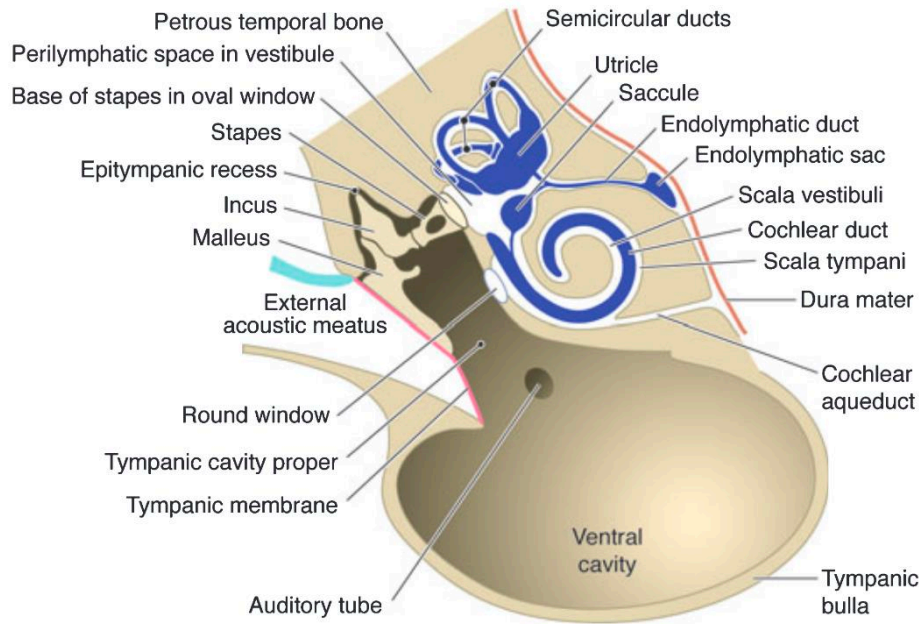


Figure 1 Schematic drawing of the inner ear, middle ear, and external acoustic meatus of a dog. [11]

2.2 Classification and aetiology of otitis externa and media.

The causes of otitis externa are classified into four main aetiopathogenetic categories: predisposing factors; primary factors; secondary factors and perpetuating factors. Predisposing factors are alterations of the ear anatomy and hair amount related to breed, habitual factors affecting ear canal moisture, such as swimming and grooming, or modifications in the ear canal flora, thus increasing the animal's risk of developing otitis externa. Primary factors causes otitis without any additional triggers.[13] Secondary factors usually do not cause problems in a healthy ear but can cause issues in the presence of primary or predisposing factors.[1] Perpetuating factors are those that hinder the remission of, or even aggravate an already present otitis and inflammatory response may still persist even if the primary cause has been eliminated.[14]

Morphologic categorisation can be split into reactive or infective, whereby the former can be identified by acute erythematous reactions or even chronic proliferative and verrucous aspects of the disease. The latter involves acute and chronic purulent inflammations as well as parasitic and fungal infections. These morphologic changes are usually detected upon otoscopic examination.[15]

Specific causes of OM include bacterial infection, allergic reactions, ascending infection, infection originating from the nasopharynx across the Eustachian tube, haematogenous route of infection, trauma, foreign bodies, inflammatory polyps, fungal

infections, cholesteatoma, neoplasia or even congenital deformities of the external ear canal or the pharynx. [16, 17]

Some breeds are also considered to be predisposed to developing from otitis media and those breeds include but are not limited to the CKCS and the boxer. The reason why these breeds are predisposed is still unclear but is speculated to be due to obstruction of the Eustachian tube. [18] Moreover, dogs with cleft palates, are predisposed to OM due to an impairment in their Eustachian tubes. [7]

Table 1 Causes of otitis externa. [13]

Predisposing factors	Primary factors	Perpetuating factors/ Secondary factors
<p>Anatomical factors</p> <p>Pendulous ears</p> <p>Stenotic canals</p> <p>Increased ceruminous glands</p> <p>Excessive hair</p> <p>Environmental triggers</p> <p>Increased humidity of ear canal</p> <p>High environmental temperature and humidity</p> <p>Swimming</p> <p>Previous otitis</p> <p>Abnormal epithelium</p> <p>Stenotic canals</p> <p>Failure of epithelial migration</p> <p>Tumours or growth</p>	<p>Allergies</p> <p>Parasites</p> <p>Foreign bodies (foxtails)</p> <p>Keratinisation disorders</p> <p>Autoimmune diseases</p>	<p>Chronic changes of the ear canal.</p> <p>Otitis media.</p> <p>Chronic infection.</p> <p>Bacteria.</p> <p>Yeasts.</p> <p>Overcleaning.</p> <p>Irritative substances.</p>

2.3 Otitis externa

OE is one of the most prevalent ear canal related diseases presented in cats and dogs. This condition is associated with acute or chronic inflammation/infection of the external ear canal's epithelium or sometimes only affecting the ear pinna with or without the involvement of neoplasm or hyperplasia. [15, 19] OE, having multifactorial causes, can be categorised into the aforementioned PSPP system: Primary, secondary, predisposing, and perpetuating factors. OE may also occur due to a combination of dynamic alterations

in anatomical, physiological, and microbiological conditions of the external ear meatus. [20] The common clinical signs seen in the case of otitis are head shaking, pruritus, pain, fetor, ear canal inflammation or an apparent discharge can be seen where in the case of OM, these clinical signs would be more severe in nature. [21] It is worth noting that the most common primary cause of OE in a study comprising 100 dogs was allergic dermatitis, involving 43 dogs. [19] Another method of clinical classification of OE is erythroceruminous or suppurative otitis. Erythroceruminous otitis is marked by erythema, itchiness, and a ceruminous to seborrhoeic secretion most commonly due to *Staphylococcus* or *Malassezia* excessive proliferation. On the other hand, suppurative otitis is marked by erythema, ulceration, discomfort, and purulent auricular secretion. [22]

2.3.1 Predisposing factors

Predisposing factors are those that make the ear canal more favourable to developing otitis and do not independently cause any harm. These factors comprise anatomical predispositions, elevation in the environment's temperature and humidity, excessive hair around the ear canal, obstructive ear diseases, or even immune system-related diseases. [14] Obstructive lesions such as tumours or inflammatory polyps hinder the proper drainage of exudate and thus may lead to secondary infections. [23] The treatment plan for otitis externa often depends on the adequate identification and control of both predisposing and primary factors. [24] It has also been shown that due to the effect of androgens causing higher sebum production, male dogs may be predisposed to developing otitis externa, as opposed to oestrogens which have the opposite effect. [25]

2.3.2 Primary factors

Since the epithelium of the external canal is an adjunction to the skin, primary otitis can either be related to only the ear only or be part of a generalised dermatological issue. [10] Primary factors are those that will directly initiate the inflammatory process in the ear canal with the major primary factors being allergy, parasites such as *otodectes canis*, *demodex canis* or *otobius megnini*, canine atopic dermatitis, food, and contact allergic reactions. [23, 26] Failure to recognise and control primary factors may aggravate or cause recurrent otitis in the dog, hence specific diagnosis and treatment plan is necessary for successful recovery. [23, 27]

2.3.3 Perpetuating factors

Perpetuating factors, sometimes also classified together with secondary factors/causes, (such as iatrogenic irritation, bacterial and yeast infection) are those that maintain or intensify the inflammatory process. [26] Perpetuating factors are usually problematic even after the resolution of primary and predisposing factors since they hinder the healing process of the disease thus causing chronic otitis or increasing the chances of relapse. [13] The inability to recognise these causes may result in unsuccessful treatment. The most common perpetuating factors are: bacteria which are typically successive to a primary cause; yeasts, commonly *Malassezia* which multiply due to an insult in the ear canal's flora; the presence of otitis media and progressive pathological alterations of the ear canal such as ear canal stenosis, TM rupture or even hyperplasia. [27]

2.4 Otitis media

OM which is the inflammation of the middle ear, involving the TM and tympanic bulla, usually occurs due to recurrent or even chronic OE in dogs and mostly due to upper respiratory infections in cats. [28] Even though the percentage of incidence of primary OM is quite uncommon, the occurrence of OM secondary to OE is relatively elevated. [29]

It is interesting to point out that the normal flora of the middle ear consists of some bacteria such as staphylococcus, streptococcus, *Pseudomonas*, *Escherichia coli*, and also sometimes yeast with the absence of exudate or inflammatory cells, hence these are unlikely to cause any issues in normal circumstances. [30, 31] However, in the presence of infection, *Proteus* or *Pseudomonas* species are often identified and these have not been observed in healthy dogs. Parasites such as *Otodectes cynotis* mite will occasionally cause alteration the TM and give rise to OM, and this mainly occurs in cats. Neoplasia, Cholesteatoma, inflammatory polyps, or even foreign bodies such as awns could also be the cause of OM. In addition, fungal infections with *Malassezia canis* or *Candida* species, although rather unusual, may be causative agents to OM. [29] Viruses are regarded to be the least prevalent cause of canine and feline otitis media. They reach the middle ear via the eustachian tube or by hematogenous route. [32] It is also interesting to point out that an intact TM does not rule out the potential presence of an OM [29] A previously fissured TM that healed may close in pathogenic microorganisms and eventually result in suppurative OM. [33]

OM can be classified into acute OM or OM with effusion. Acute OM refers to an acute inflammation of the middle ear canal's mucosa with the presence of discharge

while OM with effusion refers to the occurrence of discharge but without the severe symptoms of infection. [34] Inflammatory acute OM may also be caused during ear cleaning where the TM has been fissured due to iatrogenic origins. [2] Suppurative otitis is frequently seen as the long-term development of chronic or intermittent otitis which can progress for months or even for years. [35] It is worth noting that chronic OM is customarily suppurative, with a copious volume of liquid flowing into the ear canal.[33]

2.4.1 Clinical signs

As previously mentioned, OM should always be suspected and confirmed or ruled out in dogs suffering from chronic or even recurrent external ear canal issues. . [29] The clinical signs of OM are often similar to those of OE, although they are more likely to be more intense and chronic, and can even progress to facial paralysis.

These clinical signs could be pruritus, swelling, erythema, or even the presence of ulcers in the ear canal. [16, 21] Every so often, severe pain due to OM may induce head tilt in the dog , similarly to any kind of anomalous vestibular function. Some dogs would also become lethargic, refuse to eat, or even develop a fever. [29] If the dog still has any appetite, discomfort will be seen while eating and chewing which is typical of the development of OM involving the temporomandibular joint and a possibly swollen and inflamed tympanic bulla which are situated adjacent to each other. [28] In the case of a patient presenting with an aural haematoma, it is recommended to check for the presence of OM. When owners complain about perceived deafness or reduced hearing of their pets, OM should be suspected since the presence of fluid within the middle ear cavity can reduce hearing.. [33]

Other commonly seen clinical signs are head shaking, discharge from the ears, or even malodour. Facial nerve anomalies such as facial palsy, Horner's syndrome (i.e. enophthalmos, ptosis, miosis) due to lesions of the sympathetic branches of the facial and/or trigeminal nerves, droopy lips, or secondary keratoconjunctivitis sicca may also be suggestive of OM since advanced infection may affect the facial and/or trigeminal nerves. [2, 16, 30] Keratoconjunctivitis sicca may be caused due to reduced tear production as a result of damage to the facial nerve which is responsible for lacrimation. [29] The presence of nystagmus or even deafness may correlate with otitis interna. [16]

2.4.2 Pathogenesis.

There are three routes of infection that can instigate OM and these are: the descending route which originates from OE; the ascending route originating from the upper

respiratory system; the haematogenous route or can even be linked to nasopharyngeal polyps. [36] The most typical origin of OM would be through a ruptured TM resulting from an infected external ear canal. [33]

The descending route of infection occurs through the TM and usually begins with OE. Debris such as foreign bodies, plants awns, or even hair related to OE which decompose, generally causing irritation, and can result in the rupturing of the TM thus enabling infection of the tympanic cavity, thereby causing OM with the accumulation of exudate within the cavity and eventually entail the thickening of the bulla tympanica. [29, 36] This is also referred to as secondary OM, the pathogenesis of which is multifactorial, as mentioned above. [33] Due to the anatomical L-shaped organisation of the dog's external ear canal, during OE, the exudative fluids produced containing proteolytic enzymes amass adjacent to the pars flaccida of the TM. The resulting inflammation and enzymatic dismantling of the TM result in the necrosis of the epithelial layer and eventually may cause the rupture of the TM.[2]

Ascending OM usually originates from the upper respiratory system via the Eustachian tube which links the nasopharynx to the middle ear cavity. This route of infection is quite uncommon in dogs but has been observed in cats typically as a consequence of upper respiratory disease. [29] The pathogens would travel from the Eustachian tube to the middle ear cavity and cause hyperaemia and swelling of the mucoperiosteal lining which is a one-cell layer thick mucosal epithelium that lines the tympanic bulla. [10, 36] The narrowing of the Eustachian tube due to mucosal edema, negative pressure within the tympanic cavity, and nasopharyngeal abrasion could also be linked to the development of secretory OM. [37] The exact mechanism for the evolution of OM in cats has not yet been documented but bacterial samples taken of the tympanic bulla of cats suffering from OM correlate with those present during respiratory infections. It has also been speculated that very young animals' chronic viral upper respiratory diseases could be linked to OM in cats. [2]

The haematogenous route of infection is linked to infectious agents present in the blood which may affect the middle ear, however, this way of infection is not common. [29] Viral agents, which occur on very rare occasions, are thought to be associated with the haematogenous spread of infection. [32]

2.4.3 Bacteria

As previously stated, OM has multifactorial causes including infectious as well as non-infectious ones. The infectious factors include bacterial, fungal, and rather infrequently

due to viral causes. Bacterial causes are the most frequent cause of infectious OM that has been cultured. [32] The most routinely isolated bacteria cultured during OM proceeding chronic OE in dogs include: *Staphylococcus pseudintermedius*; *Pseudomonas aeruginosa*; β -haemolytic *Streptococcus*, and *Staphylococcus epidermidis*. [32, 38] Frequently, dogs with otitis media usually have recurrent or even chronic bacterial OE. [2] Interestingly, *Pseudomonas* species (spp) and *Proteus* spp are often found as causative agents of OM and these are not commonly part of the dog's healthy ear flora. [29] In very rare cases, *Streptococcus equi* subspecies *zooepidemicus*, causing OM or otitis interna, could play a role in developing secondary meningoencephalitis, that is, intracranial sepsis in cats and dogs. [39, 40] Cytology should be performed in all cases of suspected bacterial otitis for accurate diagnosis as well as for adequate treatment plans. [41]

Pseudomonas spp or any other gram-negative, rod-shaped bacteria are typically not present in healthy canine ear flora. *Pseudomonas*-related infection, commonly linked with *Pseudomonas Aeruginosa* (PA), is usually manifested as acute suppurative otitis, accompanied by acute inflammation, ulceration, and pain which typically calls for immediate treatment. [42] It has been speculated that *Pseudomonas* spp-involved in causing otitis media in cats and dogs often develop biofilms. [32] Biofilm genesis appears on the middle ear's mucosa in the case of chronic OM and is a complex arrangement of bacterial colonies leading to antibiotic resistance or even resistance to the host's immune responses. [43] PA produces proteases that hinder the functioning immune system's cells and impede local immune response thus providing an adequate condition for bacterial proliferation and thus resulting in chronic infection. [44] PA can cause chronic suppurative otitis either on its own or can be associated with *Proteus mirabilis*. [45] *Proteus mirabilis*, a gram-negative rod-shaped bacterium, is usually linked to other pathogens and very rarely causes infection on its own. [46] OE and OM caused by PA have been reported in up to 35 percent of cases. Dogs with *Pseudomonas* spp-caused otitis will often be presented with a copious amount of purulent exudate and this can be unilateral or even bilateral. [41] Due to mineralisation, the ear canal may feel firm upon palpation and the animal will exhibit discomfort due to the propagation of the infection. If the infection spreads into the inner ear, the prognosis will become guarded. [47] Furthermore, in case of chronic infection, lichenification, hyperpigmentation, or even repetitive pruritus of the pinna causing trauma may occur. [41]

The genera *Staphylococcus* are gram-positive cocci-shaped bacteria. [48] *Staphylococcus Pseudintermedius*, a coagulase-positive microorganism, is typically

linked to skin and ear infections in canines and felines where special attention must be given to methicillin-resistant *Staphylococcus pseudintermedius* (MRSP). [49] In Petrov's study, coagulase-positive *Staphylococcus* was the most frequently cultured microorganism in more than 82% of dogs suffering from otitis. Coagulase-positive *Staphylococcus* otitis is generally associated with the fungus, *Malassezia pachydermatis*. [46] and it has even been documented that *Staphylococcus* instigates the proliferation of *Malassezia pachydermatis*. [33] *Staphylococcus pseudintermedius* is the most prevailing microorganism cultured in the case of OM and polyps in felines. [2] Since *Staphylococcus* and *Streptococcus* spp are typically cultured from the middle ear of healthy dogs, consequently, their involvement as the primary causative agent of the infection is doubtful. [29] The identification of *Staphylococcus* spp as a cause of OM and OE could be due to an impairment in the host's immune system and a change in the skin barrier function as a result of predisposing factors such as atopic dermatitis, surgical interventions, parasites or even immune-mediated diseases. *Staphylococcus pseudintermedius* also partakes in the biofilm formation and thus can be resistant to antibiotic treatment and can also evade the host's immune system's defence mechanism. A toxin produced by *Staphylococcus pseudintermedius*, the exfoliative toxin, instigates erythematous skin, desquamation, and crusting of the affected skin. [49] The fluid secreted during *Staphylococcal* otitis is typically ceruminous-purulent and the ear canal is often inflamed and pruritic. [50] In the case of canine pyoderma which is often caused by *Staphylococcus pseudintermedius*, an adequate otic examination should be carried out since the dog will have a greater chance of developing a secondary condition caused by the bacteria within the ear canal. [51] Furthermore, *Staphylococcus*, amongst other bacteria, fungi, parasites, and foreign bodies are all potential causative agents of granulomatous lesions of the ear canal. Granulomatous lesions can be correlated with exudate and ulcers and the primary cause must be identified via appropriate culture for proper treatment. [52]

Corynebacterium spp are gram-positive bacteria that are non-uniformly rod-shaped microorganisms. [53] *Corynebacterium auricanis* is the most typically cultured species in the dog's external and middle ear canal, both in their healthy flora and in case of infection. It is also worth noting that *Corynebacterium* spp has not been cultured from the ears of intact cats but has been isolated in the cases of otitis. [54] *Corynebacterium* are in almost all cases cultured together with other microorganisms such as *Staphylococcus pseudintermedius* and *Malassezia pachydermatis*. [54, 55] Clinical signs of *Corynebacterium* spp-associated otitis include an erythematous ear canal, the

presence of purulent exudative fluids, ceruminous secretions, stenotic ear canal, nodular proliferation or even calcification. [54]

Proteus mirabilis is a gram-negative rod-shaped bacterium. [56] *Proteus mirabilis*-related OE and OM are usually associated with other microorganisms such as *Staphylococcus pseudintermedius*, *Escherichia coli*, or even *Malassezia pachydermatis*. [46] In the case of suppurative otitis in dogs, PA, in combination with *Proteus mirabilis* have been found to be a major aetiological factor. [45]

2.4.4 Fungal otitis

Fungi have numerous common functional and structural features with animal cells. Fungi are saprophytic, which can become opportunistic organisms under specific conditions, or can also be pathogenic organisms that cause disease upon colonization of the ear. [57] *Aspergillus* and *Penicillium* spp are saprophytic fungi not found in the normal ear flora of the dog while *Malassezia* spp are opportunistically pathogenic fungi that, while are a part of the canine ear flora (and of Devon Rex and Sphynx), may cause infection in the presence of predisposing or primary factors. [58] *Malassezia* spp, particularly *Malassezia pachydermatis*, is the most frequent fungal pathogenic perpetuating factor involved in canine otitis [59] while opportunistic fungi, naturally present in the ear flora these yeasts can cause a secondary infection. Diseases caused due to saprophytic microorganisms occur as a consequence of alterations in the dog's immune system due to acquired or congenital immune deficiencies, during the course of any immunosuppressive therapy, or even due to chronic conditions such as diabetes mellitus and Cushing's disease. [60]

Aspergillus niger, a saprophytic fungus, is usually found alongside other microorganisms such as *Staphylococcus* and *Proteus mirabilis* in the case of OE and OM in the dog since the fungus is believed to proliferate in the presence of these bacteria. [61] Otitis media caused by *Aspergillus* spp are usually seen as a unilateral OE/OM in cats and dogs most probably relating to immunosuppression, foreign material, or even prior antibiotic administration. *Aspergillus* spp-associated otitis involves the copious production of brown ceruminous discharge, purulent exudate, and yellow auricular secretions as well as the common occurrence of a TM perforation. [59]

Malassezia pachydermatis, a yeast, is mostly cultured in the case of patients with an increased cerumen production. *Malassezia pachydermatis* is considered to be the most predominant fungal causative agent of otitis. It is worth noting that any modification in lipid concentration present in the cerumen usually attributable to an existent atopic dermatitis plays an important factor in the pathogenesis of otitis caused by *Malassezia*

pachydermatis. [60] *Malassezia pachydermatis* infection results in typical clinical signs including skin erythema, and moderate oedema with dark-coloured cerumen. [62] Coinfections of *Malassezia pachydermatis* usually happen with *Staphylococcus*, *streptococcus*, and *E. coli* spp. The presence of inflammation in the ear canal exacerbates the proliferation of yeast due to the damaged otic epithel. [63] According to a few studies, some breeds such as the German shepherd, the poodle, and the Yorkshire terrier had a higher incidence *Malassezia pachydermatis*-linked otitis. [64]

2.4.5 Inflammatory polyps

Inflammatory polyps are commonly observed in the external ear canal and tympanic cavity of felines and are benign, non-neoplastic masses in cats while being quite uncommon in dogs. These non-neoplastic inflammatory masses may emerge from the mucosal layer of the tympanic cavity or the middle ear, the auditory tube, or even from the nasopharyngeal space. [65] The causes of nasopharyngeal polyps in cats are speculated to be due to congenital deformity due to embryonic structural remnants or as a reaction owing to chronic viral infections, specifically due to long-term respiratory issues owing to feline herpesvirus-1 and feline calicivirus-1. [66]

Polypoid masses developing from the tympanic bulla into the ear canal tend to appear as balloon-like reddish proliferative tissue, typically limited to the middle ear in dogs, and are usually the causative agent of OE and OM. [12] Polyps usually develop as single masses from the Eustachian tube into the nasopharyngeal cavity of the cat where it can cause dysphagia, stertor, retching, [66] upper respiratory signs, or OM which may present as peripheral vestibular signs or even Horner syndrome. [67] Masses emerging from the middle ear cavity are prone to expanding through the TM into the external ear canal resulting in the drainage of fluid from the middle ear cavity into the external ear canal and even head shaking due to discomfort. On rare occasions, the polyps can be presented as numerous small masses mostly originating from the TM. [68] In one dog, an inflammatory polyp with smooth mucosal surface and fibrous texture emerging from the mucosa of the auditory tube was observed. [67] The cytological composition of a polyp is mostly inflammatory cells with an epithelial layer. [69]

Recurrent and intermittent low-intensity inflammation may ultimately lead to dysplastic or hyperplastic alterations that may act as predisposing factors to neoplastic growth. Moreover, the occurrence of these masses may obstruct the ear canal entirely thus hindering epithelial migration and as a consequence, debris and cerumen will remain inside the ear canal thus causing more inflammation. [68]

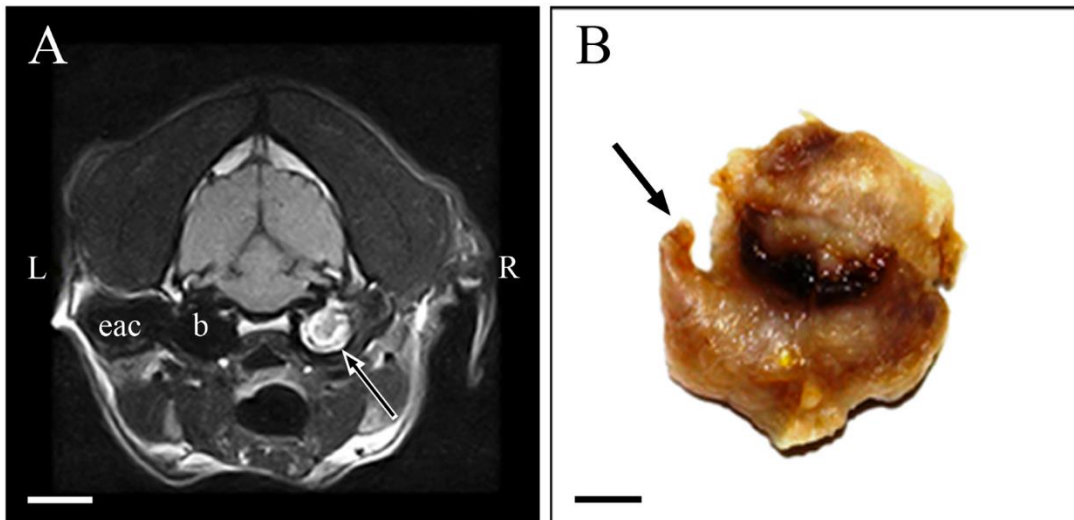


Figure 2 = magnetic resonance image showing a transversal scan section of the skull.

A hyperintense growth is seen in the right tympanic bulla (arrow). Left (L), right (R), the external auditory canal (eac), tympanic bulla (b). B = polyp removed from the tympanic bulla. [67]

Inflammatory polyps can be both unilateral or bilateral and the usual treatment approach would be ventral bulla osteotomy (VBO) in cats and more commonly total ear canal ablation (TECA) and lateral bulla osteotomy (LBO) in dogs. [12] Relapses have not been documented following surgical intervention while recurrence may occur in case of treatment by traction/avulsion. [65]

2.4.6 Cholesteatoma

Aural cholesteatoma, more suitably named tympanokeratoma, is an epidermoid cyst that is a destructive and expandable mass of keratinizing epithelium that commonly emerges in the middle ear [70] and can appear as actively growing but is, in fact, non-cancerous in nature. [71] These growths are generally composed of keratin scraps surrounded by keratinizing stratified squamous epithelium and they can be presented as congenital or acquired. [72] The progressive build-up of this abnormal keratinization results in the continuous expansion of the cyst thus causing compression and eventual

damage to the adjacent tissues. The growth and potential rupture of the cholesteatoma will result in further inflammation of the middle ear and may even become infected. [71] Moreover, a copious amount of keratin debris in the middle ear cavity may enable bacterial biofilm production which will cause resistance upon antibiotic application. [73]

Congenital cholesteatoma is quite rare in dogs and is usually an embryonic developmental defect that happens due to the inclusion or remnant of squamous epithelium which develops into a cyst in the middle ear cavity caudal to an intact TM. [72] There are four pathogenesis routes involved in the acquired form of aural cholesteatoma: metaplasia of non-keratinized epithelial cells of the middle ear; prolapsing of the TM into the middle ear causing adhesions; relocation of the squamous epithelial cells from the marginal border of a TM perforation into the middle ear, and relocation of keratinizing epithelial cells of the TM into the subepithelial cavity. Interestingly, in dogs, aural cholesteatomas are almost always developed in the middle ear and are linked to chronic OM and as a result, are regarded as acquired. [74]

Aural cholesteatomas usually appear as whitish-yellow pearly protrusion emerging from the TM or from the middle ear cavity. Diagnosis is done via otoscopy, computer tomography (CT), or magnetic resonance imaging (MRI). [75] The clinical signs that can be observed during the presence of a tympanokeratoma include: facial palsy; ataxia; nystagmus; circling; one-sided atrophy of the temporal and masticatory muscles; dysphagia; pain when opening the mouth while trying to bark; lysis of the petrosal bone or the existence of chronic OE or OM. [71] In extreme cases, aural cholesteatomas and damage the bordering bone, apply pressure on neighbouring tissue, and eventually initiate inflammatory processes and result in necrosis. [76] Bacterial infection often occurs concurrently with aural cholesteatomas and the microorganisms frequently cultured are *Staphylococcus pseudintermedius*, PA, or *Streptococcus* spp. [75]. Additionally, in some cases, cholesterol granuloma can be diagnosed along with aural cholesteatoma. Cholesterol granulomas are benign, growing lesions containing cholesterol granules that emerge from the middle ear canal. [74] Chronic OM with concurrent aural cholesteatoma has been reported to extend to the central nervous system as meningitis has been confirmed in several cases using cytology. [73] Surgical intervention, namely, TECA-LBO or less commonly VBO, are used as a primary treatment plan. [72]

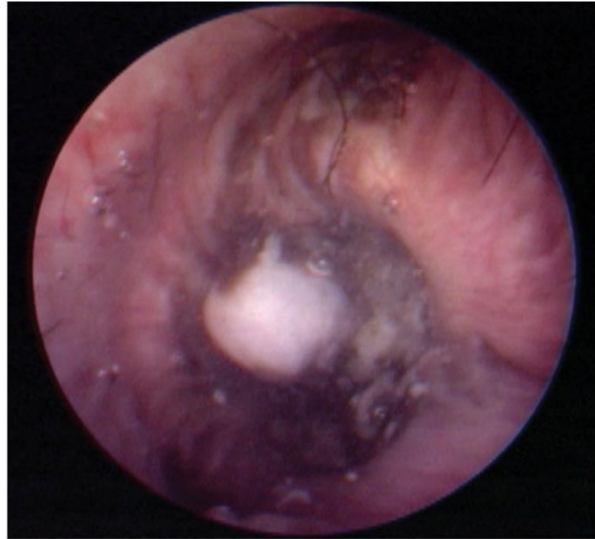


Figure 3 Otoscopic image of the horizontal ear canal in a dog. A large, solid white mass can be seen protruding from the canal. [75]

2.4.7 Tumour

Neoplastic disorders in the ear canal are not very common and typically emerge from the external ear canal and the presence of concurrent bacterial or fungal infection may mask the primary cause of the diseased ear canal. Any mass found on the ear surface should be considered neoplastic until proven otherwise by histopathological evaluation of biopsy samples, fine needle aspiration, radiography, and cytology. [27] Moreover, the progression of hyperplasia and neoplasia often evolve into incomplete or absolute blockage of the ear canal, thus, entailing intermittent and long-lasting contact with ceruminous fluid which is speculated by researchers to be carcinogenic. [68] Interestingly, the proportion of benign and malignant neoplastic disorders in dogs are more or less similar and the most common type of tumour that occurs in dogs would be associated with the ceruminous glands. [77]

Benign tumours often appear elevated, stalked, with a non-uniform structure, and ulcerated while malignant tumours seem to be elevated, ulcerated, and have wide bases. The most frequently seen benign aural tumour types in dogs are: polyps; sebaceous gland adenomas; basal cell tumours and ceruminous gland adenomas while the most often seen malignant aural tumours are: ceruminous gland adenocarcinomas; carcinomas of unknown sources and squamous cell carcinomas. [78] Furthermore, neoplastic disorders involving the middle ear canal may originate from the external ear canal, namely, ceruminous gland adenomas and carcinomas. [79] With a middle ear neoplasm, the

tympanic bulla may be destroyed by osteoclasia or bone atrophy caused by pressure necrosis caused by the weight effect of an enlarging tumour. [79]

Ceruminous gland neoplasia, more precisely, adenoma and adenocarcinoma, is microscopically quite similar to apocrine sweat gland tumours since ceruminous glands are reorganised sweat glands found within the external ear canal and this type of tumour tend to prevail in middle-aged to older-aged animals. It is believed that in the presence of chronic otitis, the risk of developing this tumour is significantly higher, and furthermore, cocker spaniels are predisposed. [80] Ceruminous gland adenoma, being benign, often appear along with those clinical signs that would typically be observed in the case of obstructive OE, such as pruritus, shaking of the head, malodor, purulent exudate with the occasional presence of blood. Ceruminous gland adenomas are usually elevated, stalked, appear as single or multiple growths, and may sometimes obstruct the ear canal. Occasional secondary bacterial infection can be seen. [52, 77] Ceruminous gland adenocarcinoma, being malignant in nature, appears to be invasive and ulcerative instead of being obstructive like the benign counterpart. [77]. Interestingly, it has been documented that chronic parasitic ear infections, more precisely, mite infestation, seem to be a major causative factor in the evolution of ceruminous gland tumours in foxes. [80]

Squamous cell carcinoma is a malignant tumour causing local invasion, is often ulcerated and proliferative with the trend to be rapidly growing. [52] Several predisposing factors exist for the development of squamous cell carcinomas, such as extended sunlight exposure, carcinogenic components of the medication used and found in the animal's environment, electromagnetic radiation, or chronic skin conditions in which the presence of ultraviolet radiation acts as a promoter of the neoplastic development. [81] Aside clinical signs typical of middle ear infections, dogs suffering from squamous cell carcinomas within the middle ear would show discomfort when trying to open their mouths occurring due to pronounced local degeneration of the neighbouring bony composition. [68] Interestingly, it has been reported that otic squamous cell carcinoma in dogs is more destructive than ceruminous gland tumours in dogs. [78]

Typical clinical signs observed in the case of middle ear tumours are: painful ears; putrid-smelling discharge; soreness when attempting to open the mouth; [82] and vestibular symptoms. [80] In the middle ear's neoplastic disorder, radiographic diagnostic methods can be used and a few aspects can be noted, namely: lysis and the deformation of the wall of the bulla tympanica, probably due to pressure caused by the

tumour; bone proliferation and tissue inflammation in the nearby area may also be noted. [79]

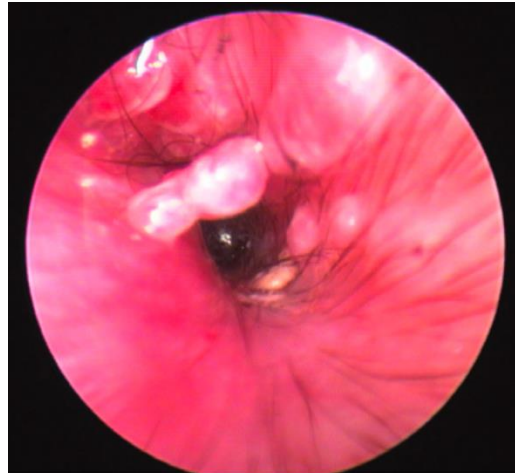


Figure 4 Stalked ceruminous gland adenoma. [77]

2.4.8 Primary Secretory Otitis Media

Primary secretory otitis media (PSOM) also referred to as OM with effusion, secretory OM or “glue ear” in human cases, is the filling to a very viscous mucous in the dog’s middle ear, especially seen in the CKCS where a bulging, opaque but intact TM can be seen upon examination with an otoscope. [83, 84] Another predisposed breed of PSOM is yet again a brachycephalic breed, the boxer, which has a relatively high incidence of this condition. [85] According to recent research, bilateral OME has been linked to CKCS with more extreme nasopharyngeal anatomical structure than CKCS without the condition and that brachycephalic morphology is substantially correlated with the occurrence of OME in dogs. [86]

The clinical signs typically seen in the case of PSOM are: pain often located around the head and neck; spontaneous vocalisations; head and neck itching; cervical pain; aural pruritus; exaggerated yawning; head shaking; facial paralysis; droopy ears or lips; holding the neck in a guarded position; ataxia; deterioration in hearing ability, or even vestibular disease. [83, 85] The rise in pressure inside the tympanic bulla induced by mucus collection causes neurological illness. Deafness is typically caused by a conductive issue caused by mucus build-up. [12] The differential diagnoses for the aforementioned clinical signs are: cervical disc conditions; inflammatory issues; intracranial diseases; secondary OM or even syringomyelia (Fluid-filled cavities form inside the spinal cord as a result of the cerebrospinal fluid blockage, particularly through the foramen magnum). [83, 87]

The fact that the majority of PSOM dogs have intact TM with the absence of OE, and that most dogs with simultaneous OE have intact TM, suggests that the origin of the disease is located within the middle ear or in the eustachian tube. The pathogenesis of PSOM is still unclear but is speculated to be due to excessive viscous mucus production, impaired drainage of the middle ear through the Eustachian tube, or a combination of the two. [84] Secretory anomalies in the middle ear can be induced by mucus overproduction or irregularities in the elimination process, which can be caused by failure of the mucociliary escalator and eustachian tube malfunction. [12] Negative pressure, induced by a shortage of aeration, pulls sterile transudate from the secretory glands in the middle ear to the mucous membrane's surface. As long as the tympanic membrane is intact and the eustachian tube is closed, the negative pressure will persist and the mucus accumulation process will continue. Secretory otitis media is thought to be caused by a failure to open the eustachian tube and hence discharge secretory material. [88] The overfilling of the middle ear with mucus and consequent bulging of the tympanic membrane, as well as the typical discomfort and neurological indications, suggest that the pressure inside the middle ear is high rather than low, at least in the later stages of the condition. PSOM development could also involve an inflammatory or allergic response. [84] Elongated soft palates have long been recognized as contributing to the disease, but excessively thick soft palates have lately been recognized as well. [85] Interestingly, bacterial infection is not considered an aetiological factor of PSOM. [89]

Diagnostic methods used to identify infectious OM in dogs are imaging such as X-ray, CT, MRI, ultrasonography, otoscopy, positive contrast canalography, pneumoscopy, and tympanometry. Furthermore, it has been reported that the use of ultrasonography is more accurate in the detection of fluid. Moreover, the use of ultrasonography enables the veterinarian to carry out the procedure without sedation as well as limiting the animal's exposure to radiation. [90] The potential treatment of PSOM include myringotomy, tympanostomy, VBO, or alternative treatment plans. [83] A myringotomy is a surgical incision made in the TM to access the middle ear. It serves to determine the presence of fluid and/or detritus in the middle ear, extract exudates from the middle ear cavity, retrieve specimens for cytological assessment and microbiological culture, evacuate the middle ear, and infuse topical otic treatment into the middle ear cavity. [91] In the case of PSOM, the middle ear fluids consist of an extremely viscous, opaque, greyish, or yellowish, solid plug that appear to occupy the whole middle ear. [84] For the treatment of canine PSOM, tympanostomy tubes may provide enough tympanic cavity drainage and aeration thus eliminating the need for numerous myringotomies. [87] Another

successful treatment plan includes a topical corticosteroid and/or systemic prednisolone with optional systemic antibiotics and/or mucolytic administration. [84]

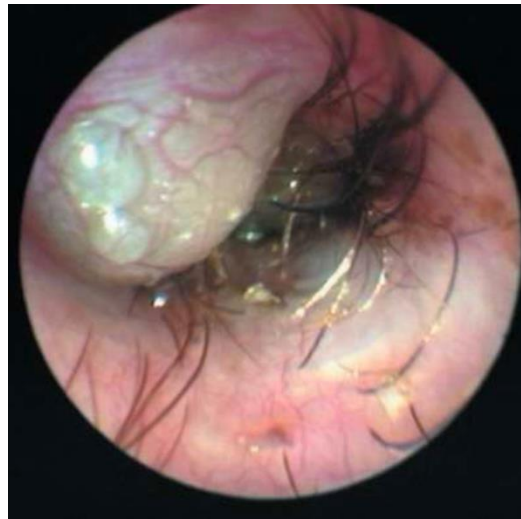


Figure 5 Bulging TM in the case of PSOM in a CKCS.[87]

2.5 Otitis interna

Otitis interna is the inflammation of the inner ear structures (the cochlea, vestibule, and the semicircular canals) and is quite rare. [92] Otitis interna seems to be linked with OE and OM and thus its causative agents could be associated with those of OM and thus may be a result of haematogenous or ascending pathway. [52] In the case of otitis interna, due to the inflammation of the surrounding tissue of the internal ear, impairment of the vestibulocochlear nerve can occur thus leading to hearing loss and other peripheral vestibular signs such as: itorticollis; spiralling movements; deafness in case of bilateral otitis interna; incoordination and nystagmus. [5, 92] Emesis may be seen in the case of otitis interna because of the vestibular link with the emetic centre of the brain. [29] Moreover, auricular discharge in the middle ear are often associated with clinical issues linked with an amalgam of internal and middle ear conditions. [82] Furthermore, The pathogens linked to otitis media may migrate to the brain and result in meningitis, meningoencephalitis, or even abscesses. [92]

There are four routes that have been reported by which bacteria can access the central nervous system from the middle and inner ear: bone corrosion and damage; direct access through normal anatomical route (vestibular fenestration, cochlea, endolymphatic duct); thrombophlebitis of the blood vessels within the skull and haematogenous pathways. [73] In felines, otitis interna has been linked with inflammatory polyps or even issues related to aural tumours. [93] MRI is the diagnostic imaging technique recommended for

assessing the inner ear properly. In the case of otitis media involving the vestibulocochlear and facial nerves to the brain, the prognosis is considered poor. [94]

3.Diagnosis

According to literature, OM in dogs is a lot more common than originally assumed. [2] Middle ear illness can be difficult to diagnose since the history, clinical signs, and physical assessment are more or less equivalent to those of external ear disease. [95] The diagnosis of OM in dogs can be challenging due to the canine ear canal's long, bending, funnel-shaped morphology, which impedes the ability to detect the TM. [2] Furthermore, many otitis media cases have an intact TM, giving the clinician the impression that nothing is incorrect in the middle ear. [96] Moreover, many dogs suffering from OM also are affected with chronic OE, which causes stenosis in the ear canal and makes evaluation of the TM difficult. [2] Because cats have relatively small ear canals, otitis media may be simpler to identify with an otoscope. Otitis media in cats is frequently a complication of respiratory illness with clinical signs such as sneezing or nasal discharge. [79] Imaging [radiography, computed tomography (CT), magnetic resonance imaging], otoscopy, positive contrast canalography, pneumotoscopy, and tympanometry may be used to diagnose infectious OM. [90]

Otoscopy is the use of an otoscope to examine the external and middle ear canal. Otoscopy is used to identify foreign materials, lesions, exudates, and pathologic alterations in the ear canal. It is useful in evaluating the tympanic membrane. [97] However, abundant proliferative tissue and debris inside the external ear canal frequently impede otoscopic examination. [95] Furthermore, otoscopy also enables for direct monitoring of numerous operations conducted with the otoscope. Ear loops, ear cleaning, biopsies, intralesional injections, and myringotomy are some of the procedures used. [97] When the tympanic membrane cannot be thoroughly evaluated with otoscopy (for example, if the canal is too narrow or obstructed by exudate), it can be evaluated radiographically by injecting contrast material into the external ear canal. This procedure is called canalography and can be used to identify middle ear disorders. [7] In the event of an tympanic membrane rupture, the patient should have an endotracheal tube inserted. Aspiration can occur when fluids in the tympanic cavity drain from the Eustachian tube into the nasopharynx as a consequence of manipulation or flushing. [2]

Radiography is a commonly available imaging technique that veterinarians are familiar with, and it is frequently the first tool chosen to evaluate the condition of the

middle ear. For the optimal positioning of the patient in order to view the tympanic bulla, general anaesthesia is required. [94] Dorsoventral, latero-lateral, rostro 30° ventral caudodorsal open-mouth (rostrocaudal open-mouth), and left and right latero 20° ventral-laterodorsal aspects (lateral oblique) are the five conventionally utilized projections. [79] In case of greater amounts of viscous exudate or tissue growths (neoplasm, polyp, or cholesteatoma) present in the air filled bulla tympanica, the whole bulla may seem radiopaque. [2] Soft tissue opacity in the bulla, sclerosis of the tympanic bullae or petrous temporal bone wall, bony growths of the petrous temporal bone, and indications of otitis externa are all radiographic abnormalities linked with middle ear disease. [94]

Cross-sectional image of the external, middle, and inner regions of the ear is possible with CT, allowing detailed visualization of the anatomical structures within. [79] CT examination of the ear canal is very beneficial in situations of OM. It can also be used to evaluate the presence and severity of neoplasia in nasopharyngeal polyps and unilateral or bilateral OE. [94] Thin slices enable the visibility of fine anatomic detail in the middle and inner ear regions. [79] Furthermore, CT offers various benefits over traditional radiography, including the absence of superimposed overlaying structures and greater soft tissue contrast. CT may be more sensitive and specific than radiography in the detection of canine middle ear illness. [95]

Alternatively to CT, MRI has been utilized to better identify the cerebral extent of the illness. [72] MRI is preferable for identifying soft tissue features including nerves, arteries, and inner ear components, whilst CT is better for assessing bone structures. [71] MRI is substantially different from radiography or CT in concept, and so provides pictures with quite different qualities. [7] In both dogs and cats, ultrasound evaluation of the bulla for fluid or air is more sensitive (but less specific) than radiography but still less sensitive and specific than CT. [32] For evaluating the middle ear, CT, MRI, and ultrasonography are all more sensitive than radiography. It has been documented that CT and ultrasonography are the best approach for studying the middle ear. The mucosal membrane of the bullae may be differentiated from exudate within the bullae on MRI images. [7]

Table 2 indication and limitation of the imaging technique. – No value, + Limited value, ++ Useful technique, +++ Optimal examination method *With canalography, ^After contrast medium administration [7]

	Radiography	CT	MRI	Ultrasonography
Detection of ruptured TM.	++ *	+	+++*	-
Detection of nasopharyngeal polyp.	+	+++	+++	-
Distinguish between tissue and fluid in the middle ear.	-	+++^	++^	-
Detect bullae thickening.	++	++	+++	+
Detect otitis interna.	-	++	+	-
Detect associated meningitis.	-	++	+	-

4. Treatment options

For maximum treatment value, therapy for otitis media therapy needs to be planned in steps in steps. The fundamental stages for the treatment of OM include: Visualize and approach the middle ear; Sample for cytology and bacterial culture; Flush the bulla; Infuse topical drugs into the bulla; Decrease inflammation with corticosteroids; Introduce systemic and topical antimicrobials; Control weekly, repeating treatment two to three times and consider surgery if no remission is achieved. [2]

If the mucosal layer of the bulla is not infiltrated by neoplastic cells or a thick layer of granulation tissue, medical therapy for otitis media can be undertaken. The removal of any material that has accumulated in the bulla is a primordial step in the medical therapy of otitis media. [4] The tympanic cavity should be cleaned under anaesthesia. Vestibular impairment, loss of hearing, facial nerve palsy, and Horner's syndrome are all possible risks in the case of lavage of the middle ear, although these conditions are considered rare. [32] Depending on cytology and culture/susceptibility findings from middle ear samples, topical and systemic antibiotic treatment should be selected. Because of their anti-inflammatory, antiproliferative, antipruritic, and anti-exudative (glandular secretory) properties, topical corticosteroids are generally be used in almost every instance of otitis media. [3] When the eardrum is punctured or completely absent, topical drugs and ear-cleaning chemicals can enter the inner ear through the round and

oval windows, causing neurologic ototoxicity which may eventually lead to deafness. [2]

Furthermore, complete bulla lavage to eliminate infective and inflammatory exudates increases the efficacy of medical treatment. Without a complete lavage in the event of bulla obstruction with inflammatory exudates and debris, conservative treatment is likely to fail. [3] Where there are waxy secretions, cerumenolytic ear cleansers should be utilized. In situations of suppurative otitis, an aqueous cleanser with disinfective properties (such as saline or tris-EDTA) is recommended. [98] If the tympanum is intact and OM is suspected, a myringotomy needs to be performed. In situations of OM, perforation of the tympanic membrane is considered to be a common complication due to its friability, greatly facilitating myringotomy. [32] The majority of myringotomies are performed on animals who have substantiation of debris in the middle ear (as diagnosed by radiography/computed tomography or magnetic resonance imaging) and have not reacted or relapsed despite adequate systemic therapy and tube deep cleaning or flushing of the ear. [97]

5. Materials and methods

Theoretical work

The first part of the thesis is a literature report presenting an overview of the causes of OM and OE in dogs, with special interest in suppurative OM. Information about the pathogenesis of otitis media was researched to understand the importance of the consequences of the disease. Moreover, diagnostic methods, treatment options, and prophylaxis were also looked for in scientific material and case studies. It is important to note that only a small number of scientific surveys have been conducted to evaluate specific causes of suppurative OM. The online database PubMed, ResearchGate, and Google Scholar were used to get access to scientific papers, studies, reviews, and the following domains were entered in google scholar for research purposes:(((Otitis) AND (media)) AND (dog)) OR (dogs) (dog or dogs or canine); (ear or ear infection or otitis) and bacteria; and (dog or dogs or canine) and (ear or ear infection or otitis).

Case review

In the second part of the thesis, the ratio of otitis media cases was evaluated in the patient data of otoscopies performed in 2020 in the Small Animal Clinic of the University of Veterinary Medicine, Budapest.

These patients were evaluated under general anaesthesia (dexmedetomidine, diazepam, and propofol induction, isoflurane maintenance) and CT examination was recommended where necessary.

The diagnosis and treatment options was categorized, and patient data was compared to that in literature.

6. Result

According to this review, the main causes of OM are bacterial infection (most commonly *Pseudomonas* or *Staphylococcus*), yeast (*Malassezia*), neoplasia, cholesteatomas, and PSOM. In line with this review, it has been seen that one of the most important steps is to properly distinguish OM from OE through proper diagnosis, that is, adequate imaging techniques and through bacterial cultures. Furthermore, a proper treatment plan is a key component since mismanaged otitis tends to be chronic and recurrent. In the case of bacterial otitis, antibiotic sensitivity tests are of utmost importance.

In our results, a total of 59 anaesthetized otoscopies were performed in 2020, out of which otitis media was diagnosed in 19 cases. Out of the 19 otitis media cases diagnosed 10 were from canine patients and 9 were feline. **(Figure 6)**

The otitis media cases were of ascending origin in 4 cases and descending in 15 cases. The causes for otitis media were bacterial in 7 cases (5 dogs and 2 cats) **(Figure 7)** the most common agent was *Staphylococcus pseudointermedius* (MRSP strain in 4 cases non MRSP in 2) with the remaining one case being *pseudomonas*. There were 6 cases of nasopharyngeal polyps involving the middle ear, all of them from cats **(Figure 8)**. Sporadic diagnoses were sterile and non-sterile abscesses relating to foreign bodies (1-1 case) **(Figure 9)** and in case of one patient, waxy, necrotizing otitis media. Foreign bodies were found in two cases

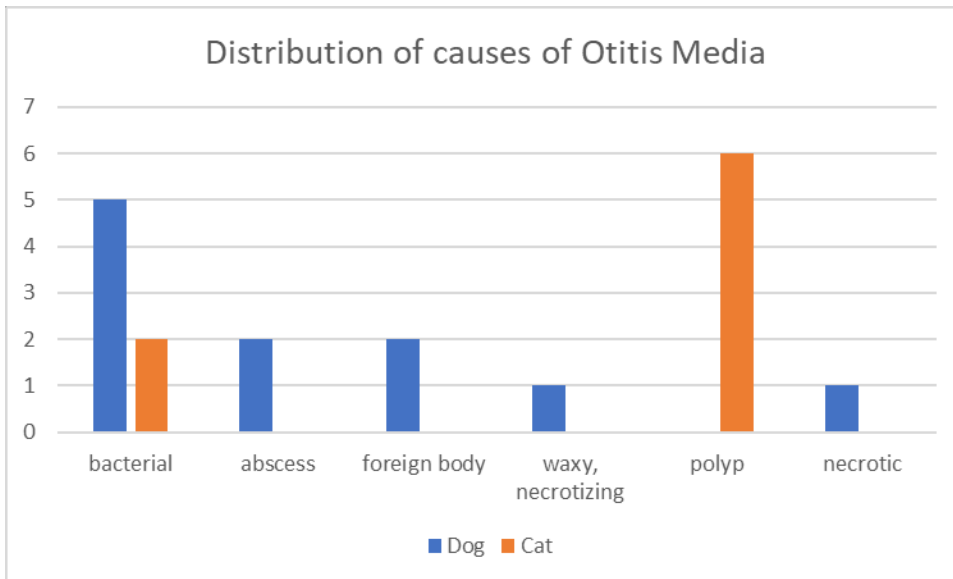


Figure 6 Distribution of otitis media causes among dog and cat cases of the Department and Clinic of Internal Medicine, University and Clinic of Veterinary Medicine, Budapest in 2020.

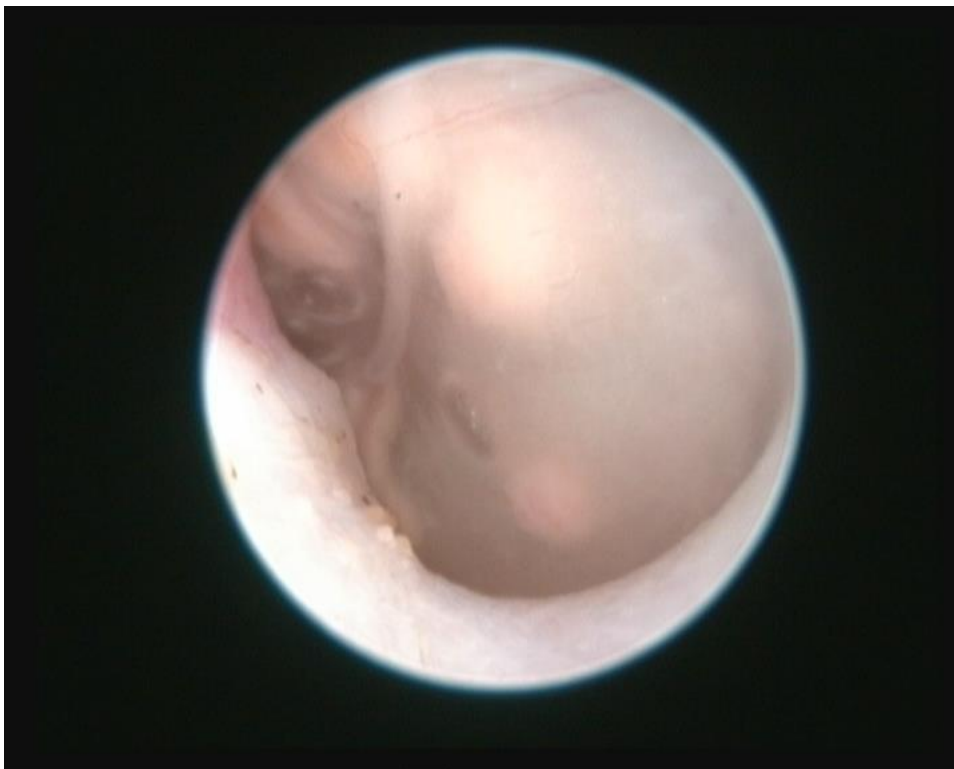


Figure 7 Bacterial, ascending otitis media in a 6 years scottish straight ear cat with head tilt and ear shaking. The droplets of purulent discharge are visible on the face of the tympanic membrane towards the middle ear.

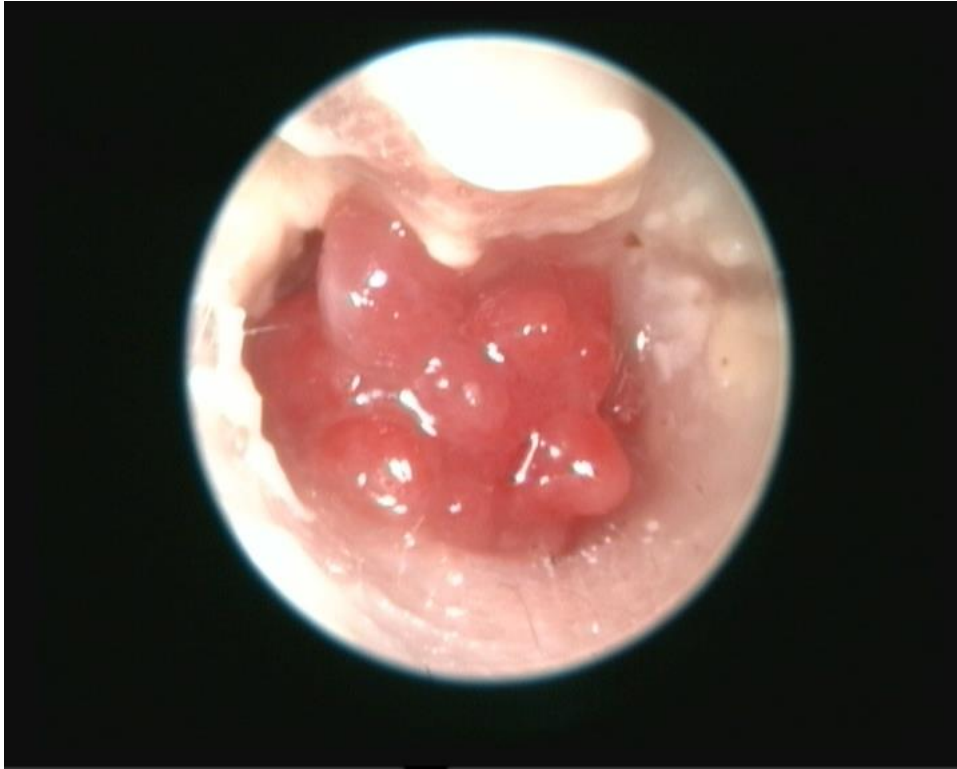


Figure 8 Nasopharyngeal polyp visible in the external ear canal of a 2 year old main coon. The mass has a distinct, pink, mucous membrane like surface.



Figure 9 Abscess caused by a demarcated foreign body in a 6 years old Vizsla. Opening of the abscess revealed fat rich purulent discharge. Culturing of the discharge was negative.

7. Conclusion and Discussion.

Suppurative otitis is typically seen as a chronic progression of persistent or recurrent OE/OM that can last months or even years. The clinical appearance of a whitish/mucinous discharge is characteristic for the disease. Cytology and bacterial culture are the two most utilized diagnostic methods in literature. [35] Most OM cases are associated with chronic/recurrent OE, although rare instances, can emerge directly as a result of increased exudate production in the middle ear and/or impaired drainage through the Eustachian tube (e.g. primary secretory otitis media seen in brachycephalic dogs and spontaneous primary otitis media in cats). [52] The chronic aspect of ear canal illness, as well as the difficulties in obtaining a cure, may be connected with mismanaged primary skin disease (ie, atopy, adverse food response, and endocrinopathy), which, if not effectively managed, may lead to otitis and secondary otic infections. However, multidrug resistance of bacterial species may be the most important factor influencing medical therapy of chronic infectious otitis. [4]

In our overview of the caseload we found a higher incidence of ascending otitis media than what is written in the literature. [52]. The cause of this discrepancy can be multifactorial, either due to overrepresentation of these diseases due to the referral nature of the clinic, or due to the limited sample size (the cases of 2020) not being representative of total patient distribution,

8. Summary

Otitis generally signifies inflammation of the skin of the ear adjacent to a bacterial or fungal infection, although sterile, primary otitis can also be caused by masses (tumours, inflammatory polyps, or foreign substances), parasites, allergic illnesses, and irritating chemical or manual cleansing routines. [15] The most accurate way for diagnosing infectious OM is to gather a specimen for bacterial cultures from the tympanic bulla (via myringotomy if required). [4] Moreover, Brachycephalic dogs, namely CKSC and boxers, are susceptible to fluid accumulation in the middle ear, most likely due to pharyngeal and/or auditory tube malfunction. Some dogs with cleft palate may also have auditory tube malfunction, which predisposes them to OM. [7]

Additionally, Diagnostic imaging techniques (conventional radiography, computed tomography, and magnetic resonance imaging) play an important role in the diagnosis of ear problems. [79] Numerous therapeutic strategies are customarily addressed, which frequently differ in the empiric selections of topical drugs and cleansers used, the

frequency and method of ear canal lavage (both in-office and at home), and the characteristics and frequencies of prophylactic therapies suggested after chronic infection resolution.[3]

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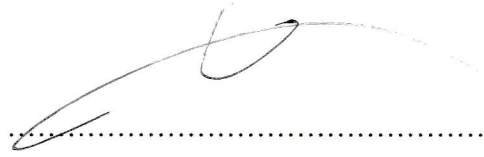
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