Department for Companion Animals and Horses
University of Veterinary Medicine Vienna

University Hospital for Small Animals
(Head: Univ.-Prof. Dr.med.vet. Iwan Burgener Dipl.ECVIM-CA Dipl.ACVIM)

Retrospective study of foreign body otitis risk factors in dogs

Diploma thesis

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Submitted by
Marc Tritsch

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Tutor: MVDr. L. Panakova, Dipl. ECVD

Assessor: Dr. B. Degasperi, Dipl. ECVS

Structure

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1 Introduction and Issue

In small animal veterinary medicine, ear disease is a common problem and plays an important role in everyday practice.

In 2017, “Ear Infection” was the second most common medical condition that lead to the presentation of dogs as patients at veterinary clinics or practices in the United States of America, according to the *Veterinary Pet Insurance Company*, a part of the *Nationwide Mutual Insurance Company,* which has access to the data of more than 650,000 insured animals (https://press8.petinsurance.com/articles/2018/march/most-common-medical-conditions-that-prompt-veterinary-visits).

Other studies indicate that up to 20 % of canine veterinary consultations are due to otitis externa (LOGAS, 1994; ANGUS et al., 2002).

Otitis externa is triggered and sustained by the interaction of different factors and causes. A common form of otitis externa is foreign body (FB) associated otitis. In case of early detection and removal of the lodged foreign body this form can be easily prevented or quickly cured. However, neglecting to remove the foreign body can lead to chronic otitis with severe inflammatory changes and possibly even otitis media (PATERSON, 2016).

In general, certain breeds, such as English cocker spaniels, miniature poodles, Labrador retrievers and German shepherds, seem to be predisposed to otitis externa (STOUT-GRAHAM et al., 1990; SARIDOMICHELAKIS et al., 2007, ZUR et al., 2011; ŚWIĘCICKA et al., 2015). Furthermore, different morphologic and physiologic characteristics, such as pendulous ears and hirsute ear canals, will also predispose individuals and breeds towards developing otitis externa (HAYES et al., 1987).

Dermatologists working at the Clinical Unit of the Internal Medicine Small Animals of the University of Veterinary Medicine Vienna (Vetmeduni Vienna) observed that some breeds (for example cocker spaniels) appeared to present with a higher incidence of foreign body associated otitis externa in comparison to other breeds.

A comprehensive search concerning foreign body associated diseases in general and, more specifically, foreign body associated otitis externa in dogs was performed. While searching for foreign body associated diseases, grass awn and other plant material was considered most relevant to avoid involving studies on irrelevant diseases, such as intestinal foreign bodies.

The search yielded only one recent study dealing with grass awn associated diseases, which could be classified into the category of foreign body associated ear diseases and corresponding risk factors in dogs (HICKS et al., 2016). Apart from that, no further scientific studies investigating a relationship between the breed or selected anatomical characteristics of the ear canal/pinna and foreign body associated otitis externa could be found.

The present retrospective study will focus on the relationship between the incidence of foreign body associated otitis externa and selected anatomical features, such as the ear shape, as well as gender, the age of the patient and breed.

Study hypotheses:

1. Dogs with pendulous ear pinnae are at higher risk for foreign body associated otitis externa compared to dogs with ear pinnae of other shape.
2. Gender has no influence on the occurrence of foreign body associated otitis externa.
3. Foreign body associated otitis externa is more frequently seen in younger patients.
4. Some breeds have higher risk for foreign body associated otitis externa.

2 Literature Survey

2.1 Anatomy and Function of the Canine Ear

The relevant anatomy of the canine ear is shown in **Fig. 1.**

2.1.1 Function of the Canine Ear

The main function of the canine ear is auditory perception, but it also plays an important role in maintaining the sense of balance (COOK, 2004).
The ear is divided into three parts: external ear, middle ear and inner ear.
The vestibular system, responsible primarily for the perception of balance, is located in the inner ear and is connected to the brain by the vestibular nerve (HEINE, 2004).
The external ear collects acoustic waves and transfers them to the tympanic membrane, which separates the external from the middle ear. Incoming sound waves that cause vibrations of the tympanic membrane are transmitted to the middle ear and, from there, amplified and transferred to the inner ear (COLE, 2009; NJAA et al., 2012). In the inner ear, the vibrations become transduced into neuronal signals and are sent to the brain via the cochlear nerve (BREER, 2015).

2.1.2 Anatomy of the External Ear

The external ear is comprised of two parts: the pinna and external ear canal.
The pinna is the organ that accumulates acoustic waves and is located dorso-caudo-laterally to the eye (GLAZE, 2013). It consists of the elastic auricular cartilage, which is coated by well vascularized, hairy skin. The cartilage is perforated multifocally by blood vessels, the *Arteriae* and *Venae auricularis rostralis* and *caudalis* (GILLE, 2006), and gives the ear its shape, commonly described as either pendulous or erect. At the base of the ear, the auricular cartilage starts to roll in into a funnel. Its lumen then merges into the external ear canal (COLE, 2009).

The external ear canal has a tubular shape. It has a mean length of 5 to 10 cm (GRIFFIN, 2009) and is usually separated into two parts: the vertical canal and the horizontal canal.

It has an exterior framework consisting of (from distal to proximal) the auricular cartilage, which forms the vertical canal, and the annular cartilage and the osseous external auditory meatus, which is part of the temporal bone, both forming the horizontal canal (HEINE, 2004).

The external ear canal's mean diameter at its distal end is 5.8 ± 1.5 cm and at the proximal opening of the annular cartilage, close to the tympanic membrane, is 0.5 ± 0.1 cm. The length and diameters of the external ear canal correlate with the body mass (HUANG et al., 2009).

The ear canal is lined by skin containing hair follicles, as well as sebaceous and ceruminous glands. The density and the distribution of hair follicles and glands varies among different breeds. For instance, cocker spaniels are described as excessively haired in the ear canals compared to the greyhound with only "few to moderate" amounts of hair and long haired breeds such as Irish setters and spaniels have more glands than short haired breeds (STOUT-GRAHAM et al., 1990; COLE, 2009).

The vertical canal proceeds into a rostro-ventral direction and bends medially into the horizontal canal. At the transition from the vertical to the horizontal canal, there is a cartilaginous fold called luminal fold, which protrudes from the dorsal part of the canal. This fold can cause difficulties in the otoscopic examination of the external ear canal and should be flattened by careful dorso-lateral lifting of the pinna (GLAZE, 2013).

The tympanic membrane is located at the proximal end of the external ear canal. It is a semitransparent, epithelial membrane oriented in a 45° angle and composed of two parts: pars tensa and pars flaccida (ANGUS and CAMPBELL, 2001).

Pars flaccida is the smaller, pink region constituting the upper quarter, containing blood vessels. The pars tensa of the tympanic membrane has a concave shape and is the larger, greyish part with radiating strands. The manubrium of the malleus, a middle ear bone, is pinned to the medial side of the tympanic membrane. The outline can be seen from the external ear canal as stria mallearis (COLE, 2009).

The tympanic membrane plays an important role in the self-cleaning mechanism of the external ear canal. This mechanism termed as "epithelial migration" is a process of ongoing proliferation of epithelial cells originating from the umbo, the most indented point of the tympanic membrane. The newly proliferated cells will drive the keratinized cells to the

periphery and into the external ear canal, where they take part in the origination of ear wax (HEINE, 2004; TABACCA et al., 2011).

2.1.3 Anatomy of the Middle Ear

The middle ear is made up of the tympanic membrane's medial wall, the tympanic cavity, the auditory tube, the auditory ossicles and their associated nerves, ligaments and muscles (GRIFFIN, 2009).

The tympanic cavity is an air-filled hollow, enclosed by the tympanic bulla of the temporal bone and lined by a thin layer of connective tissue and simple cuboidal or squamous epithelium (HEINE, 2004; COLE, 2009).

It can be divided into three parts, the largest of which is the ventral portion. It has a wall of bone in its dorsal part, called the septum bullae, with a central opening, which enables communication between ventral and middle part of the tympanic cavity (NJAA et al., 2012).

The middle part, named tympanic cavity proper, is next to the tympanic membrane. It contains most of the auditory ossicles and the opening of the auditory tube is situated in its rostral part (COLE, 2009).

The auditory tube is the only communication channel between the middle ear and the outside, as it is the connection with the nasal pharynx. This is essential for pressure equalization within the middle ear (GRIFFIN, 2009).

The dorsal tympanic cavity is comprised of the epitympanic recess, the smallest part of the tympanic cavity. It contains the entire incus and the malleus-head (NJAA et al., 2012).

Altogether, there are three auditory ossicles in the middle ear: the malleus, which is attached to the tympanic membrane, the incus, which is connected to both other ossicles, and the stapes. The stapes has a footplate at its base. The footplate is attached to the oval window, which is an oval shaped opening in the medial wall of the middle ear that connects it to the inner ear (NJAA et al., 2012). It allows the transmission of vibrations to the inner ear's perilymph.

The round window is a second opening in the medial wall, which is covered by a diaphragm and also communicates with the inner ear (COLE, 2009).

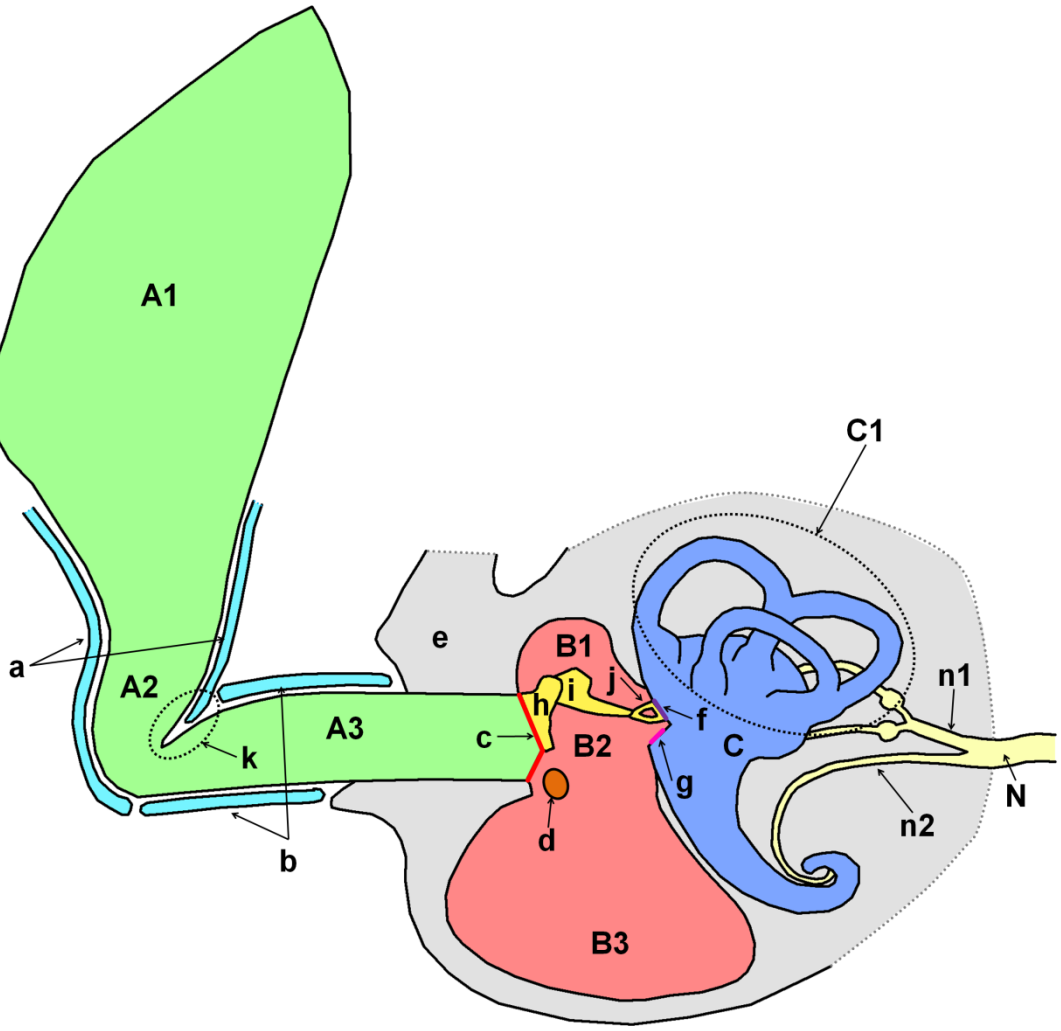

Fig. 1 *Sketch of the canine ear*

A/light green = external ear (A1 = pinna, A2 = vertical canal, A3 = horizontal canal), B/light red = middle ear (B1 = dorsal tympanic cavity, B2 = tympanic cavity proper, B3 = ventral tympanic cavity), C/blue = inner ear (C1 = vestibular system), N/light yellow = nervus vestibulocochlearis (n1 = vestibular nerve, n2 = cochlear nerve), a = auricular cartilage, b = annular cartilage, c = tympanic membrane, d = opening of auditory tube, e/light grey = temporal bone, f = oval window, g = round window, h – j/yellow = auditory ossicles (h = malleus, i = incus, j = stapes), k = luminal fold

Source: Marc Tritsch

2.2 Foreign Bodies in the External Ear Canal

The term foreign body denotes all objects possessing the ability of obstructing or irritating the external ear canal (LOGAS, 1994). Dirt, small stones, gravel, sand, impacted wax, loose hair, dried otic medications, dead insects and plant awns like foxtails are the most common examples (VAN DER GAAG, 1986; ROSSER, 2004; STOUT-GRAHAM et al., 1990) and will usually lead to unilateral, less often bilateral, quickly developing otitis externa (AUGUST, 1988). Lodged foreign bodies typically cause head shaking and ear scratching due to severe pain and discomfort. If located close to the tympanic membrane, they have more impact (COLE, 2004; LOGAS, 1994).

Plant awns can migrate through the external ear canal in a proximal direction and may penetrate the tympanic membrane and thereby cause concurrent otitis media (ROSSER, 2004).

Forceps, for instance alligator forceps, are usually recommended for removal of foreign bodies.

General anesthesia and the use of the video-otoscope are often recommended for safe removal of foreign bodies, especially those located deep in the external ear canal (COLE, 2004). In chronic cases, detection of foreign bodies might be hindered due to abated feeling of discomfort and production of exudates in the external ear canal (AUGUST, 1988).

Besides the ear, other common sites of foreign bodies are the eyes and periorbital region, skin and other soft tissues, the nasal cavity, urinary bladder and also the central nervous system and spinal cord according to other studies (HICKS et al., 2016; BUSSANICH and ROOTMAN, 1981; CHERBINSKY et al., 2010; LINON et al., 2014; DENNIS et al., 2005).

2.3 Otitis

2.3.1 Definition

Otitis is characterized as an inflammation of aural components. In the case of external ear involvement it is referred to as otitis externa, inflammation of the middle ear is called otitis

media and otitis interna is an inflammation of the inner ear (KOHN and BRUNNBERG, 2006).
The term otitis externa is often used for the description of an inflammation of the external ear canal, but since the external ear is made of ear canal and pinna the term does not necessarily exclude an additional or even exclusive inflammation of the pinna (GLAZE, 2013).

2.3.2 Otitis Externa

2.3.2.1 Classification

The classification of otitis externa follows the PSPP classification system (GLAZE, 2013).
Otitis externa is often erroneously regarded as a final diagnose, but it should rather be viewed as a symptom (KOHN and BRUNNBERG, 2006).
The PSPP classification system respects this fact by classifying the forming elements of otitis externa into causes and factors. Causes in this classification system are agents or diseases that cause inflammation of the skin of the external ear canal by themselves. Factors are elements or agents unable to cause an inflammation on their own, but they assist in its formation, contribute to the chronicity and maintenance of an inflammation by modifying aural function, physiology or structure. Factors, just like causes, must be addressed in the treatment of otitis externa, especially in chronic cases. Otherwise, they may inhibit cure or lead to recurrences. Furthermore, causes are divided into primary and secondary causes and factors are classified as predisposing and perpetuating (ROSSER, 2004; PATERSON, 2016).
Primary causes are all causes that are able to create otitis externa in a normal ear, without contribution of other causes or factors. They are often subtle and may be overlooked. Examples of primary causes are listed in **Tab. 1**.
Secondary causes are mainly infections that can create inflammation and contribute to the chronicity of the changes in already abnormal ear canals. They can also be found in normal ears, but without inducing otitis (PATERSON, 2016). They begin appearing after the environment of the ear canal has changed due to primary inflammation from a primary cause (PATERSON, 2016; AUGUST, 1988). Secondary causes are usually easy to treat but can

become recurrent or chronic if primary causes or perpetuating factors were not eliminated or treated adequately. Examples of secondary causes are listed in **Tab. 2**.

Predisposing factors are present before inflammation. They do not cause otitis on their own but raise the risk for otitis by contribution (ROSSER, 2004; LOGAS, 1994). Examples of predisposing factors are listed in **Tab. 3**.

Perpetuating factors are physiological or anatomical changes of the external ear due to ear canal inflammation and are not disease specific. As already mentioned, secondary infections are perpetuating factors that alter the ear canal environment and may inhibit the resolution of otitis if they remain untreated (AUGUST, 1988). They start subtly in many cases but have the potential to become the most severe parts of chronic otitis externa. Hence, perpetuating factors will often be found in chronic cases of otitis externa. Examples of perpetuating factors are listed in **Tab. 4**.

Tab. 1 *Examples of common primary causes of otitis externa (GLAZE, 2013; PATERSON, 2016)*

Primary Causes					
Allergy - Contact allergy - Atopy - Adverse food reaction	**Autoimmune** - Pemphigus foliaceus - Lupus erythematosus - Vasculitis	**Endocrine** - Hyperadreno-corticism - Hypothyroidism - Sex hormone abnormalities	**Foreign bodies** - Plant awns - Dirt - Dried otic medications	**Epithelialization/ Keratinisation disorder** - Primary idiopathic seborrhea - Sebaceaous adenitis - Lipid-responsive seborrhea	**Parasites** - Otodectes cynotis - Demodex - Ticks

Tab. 2 *Examples of common secondary causes of otitis externa (GLAZE, 2013; PATERSON, 2016)*

Secondary Causes		
Fungal - Yeast (Malassezia spp., Candida spp.) - Aspergillus spp.	**Bacteria** - Cocci (Staphylococci, Streptococci) - Rods: Pseudomonas aeruginosa, Escherichia coli, Proteus	**Medical reaction (topical irritation)** - Propylene glycol - Alcohol Neomycin, gentamycin...

Tab. 3 *Examples of common predisposing factors of otitis externa (GLAZE, 2013; PATERSON, 2016)*

Predisposing Factors					
Moisture - Water from swimming - Environment - Cleaners	**Conformation** - Hairy ear canals - Stenotic ear canals - Pendulous Pinnae	**Systemic diseases** - Debilitation - Immune suppression - Catabolic states	**Otitis media** - Primary secretory otitis media - Otitis media due to neoplasia	**Treatment effects** - Trauma due to clening - inappropriate solutions - altered microflora	**Obstructive ear disease** - Polyps - Cysts - Neoplasia

Tab. 4 *Examples of common perpetuating factors of otitis externa (GLAZE, 2013; PATERSON, 2016)*

Perpetuating Factors					
Middle Ear - Osteomyelitis - Debris (e. g. exsudate, granulation tissue) - Otitis media OM with foreign Body	**Tympanic membrane** - Rupture - Dilatation - Diverticulum	**Ear canal** - Changes of proliferation - Hyperplasia - Stenosis - FB	**Glandular tissue** - Hidradenitis - Hyperplasia - Dilation	**Epithelium** - Migration altering/ failure - debris-production - hyperplasia	**Pericartilaginous fibrous tissue** - Calcification

2.3.2.2 Pathogenesis

Otitis externa in dogs starts with classical, reversible signs of inflammation due to primary causes, like erythema and edema of external ear canals and pinnae. The epidermal turnover rate of the acoustic meatus increases, resulting in hyperplasia of the external ear canal's wall and a stenosis of the horizontal and vertical portion of the acoustic meatus (LOGAS, 1994; PATERSON, 2016).

The narrowed lumen in combination with the debris alters the environment of the external ear canal, promoting the occurrence of secondary infections (AUGUST, 1988).

In chronic otitis, existing changes become less reversible and both sebaceous and ceruminous glands and ducts can become hyperplastic and lead to further stenosis of the external ear canal's lumen (HUANG et al., 2009).

The tympanic membrane also becomes altered, for example dilated or edematous, and can then be prone to rupture and thereby allow for concurrent otitis media (GLAZE, 2013).

In severe chronic cases of otitis externa, the external ear canal's soft tissue will not only become hyperplastic but also ossified (COLE, 2004).

2.3.2.3 Clinical Signs

Most patients with otitis externa show signs of discomfort or pain, such as head shaking, scratching and groaning, as soon as the ear or nearby regions get touched. Self-trauma, primarily through scratching, often results in alopecia, hematomas, swelling and excoriations of the pinna or aural region (ROSSER, 2004; AUGUST, 1988).
Another common sign is bad odor due to otic discharge. Consistency and color of the discharge differs depending on the secondary infections (GLAZE, 2013).

2.3.2.4 Diagnosis

The diagnosis of otitis externa is easily confirmed based on the physical examination and otoscopy (ROSSER, 2004). Nevertheless, since otitis externa is a symptom and not a final diagnosis, a complete diagnostic procedure involves recognizing and addressing all involved causes and factors as well as a meaningful treatment plan and estimation of prognosis to ensure long-term success (GLAZE, 2013).
Secondary infections are recognized with the help of cytology of otic discharge, while bacterial cultures will identify exact species. Sensitivity testing of bacterial species is performed to estimate suitable antibacterial treatment (PIERCE-HENDRY, 2010).

Otoscopic examination can be performed with handheld otoscopes or video otoscopes.
Video otoscopes offer the advantage of better light and good magnification and the good quality records can be saved for later evaluations. In addition, they possess working channels, which can be used to flush out discharge or even hidden foreign bodies (COLE, 2004).
Otoscopic examination may detect foreign bodies, assess otic discharge and evaluate alterations of the external ear canal for the presence of abnormalities like erythema, ulceration, proliferation and stenosis. Furthermore, it allows the examination and evaluation

of the tympanic membrane and, in cases of a rupture, the detection of a concurrent otitis media (GLAZE, 2013).
In severe cases, otoscopic examination may be impossible because of pain, stress, large amount of discharge or excessive narrowing of the ear canal. In these cases, prior otoscopy and anti-inflammatory treatment to reduce swelling and proliferation before proper examination and flush under general anesthesia may be useful (ANGUS and CAMPBELL, 2001; COLE, 2004).

Cytology of otic discharge is a fast and easy to perform diagnostic method. It determines the presence and type of inflammatory cells and aids in the qualitative and quantitative estimation of bacterial and yeast organisms. In this way, cytology is very useful for identification of secondary causes and developing a treatment plan (ANGUS, 2004; ROSYCHUK, 1994).
Bacterial culture and sensitivity testing is usually performed in an external laboratory and is therefore a more expensive and time consuming diagnostic method. It is indicated in chronic bacterial infections.
These methods are indicated in severe cases of bacterial otitis externa, otitis media, or if systemic therapy is planned (GLAZE, 2013; MORRIS, 2004).

2.3.2.5 Therapy

There is a large amount of different otic products available. The choice of the right therapy or its combination depends on the underlying causes and factors, chronicity of changes and may often change over the course of treatment, dependent on the actual situation and treatment response (GLAZE, 2013).
Good owner compliance is inevitable; hence, it is very important for the veterinarian to instruct the owner comprehensively (KOHN and BRUNNBERG, 2006). It is mandatory to inform the owner how to provide the treatment and to come for rechecks. If treatment duration is estimated based on the assessment of the owner as opposed to based on the recheck results, the probability of recurrence rises (GLAZE, 2013).
An important and effective treatment is mechanic cleaning of the external ear canal for which different techniques are available.

Deep irrigations with jets of pressurized fluid or the use of ear loops and curettes should only be performed by a veterinarian (GORTEL, 2004). Rinsing the ear canal with ear cleansers and massaging the external ear canal is easy to perform and therefore suitable for daily use at home.

Discharge and pus hinder adequate otoscopic examinations and prevent optimal action of the medications. Cleaning is an effective way to remove pus and also foreign bodies from the external ear canal (NUTTALL and COLE, 2004; ROSYCHUK, 1994) and in cases with abnormal epithelial migration (GLAZE, 2013). Different ear cleansers are available, such as ceruminolytic, drying or antiseptic, so that selection of the most suitable one is possible for each individual case (NUTTALL and COLE, 2004). In addition, since some cleansers also have irritating or ototoxic properties, knowledge about the tympanic membrane's status is mandatory (STRAIN, 2012; GLAZE, 2013).

A large variety of commercial topical products exists and the majority of them consist of combinations of different agents like antifungals, antibiotics and glucocorticoids. Some topical products contain antiparasitics too. They also consist of bases of vehicles like gums, fats, cellulose derivatives or oils (MORRIS, 2004; WILCKE 1988).

This enables the veterinarian to choose the most suitable ear drops based on the empirical decision based on clinical assessment and cytology or based on bacterial and sensitivity testing for each case (CHESTER, 1988).

A further therapeutic method is systemic therapy, although topical therapy should be preferred whenever possible (MORRIS, 2004).

Systemic therapy with antibiotics or antiparasitics is primarily indicated if otitis media or ear mites are present or if topical therapy is impractical. This can be in cases when the owner is unable to administer the treatment, in cases of adverse reactions or, occasionally, when the treatment outcome is not as good as requested (CHESTER, 1988; GLAZE, 2013).

In very chronic otitis cases surgery may be necessary (LANZ and WOOD, 2004; BECKMAN et al., 1990). In the selection of a surgical approach evaluation of the middle ear's involvement is mandatory.

There are several surgical methods described and their indications must be well evaluated in advance (DOYLE et al., 2004).

Examples of common surgical techniques are listed in **Tab. 5**.

In the majority of surgical cases, the aims are removal of the proliferative or infected tissue from the external ear canal and middle ear cavity or support of ventilation and drainage through solution of congestions in the external ear canal. Some surgeries will also shorten the auditory meatus (ROSYCHUK, 1994; LANZ and WOOD, 2004).

A successful outcome therefore depends on the selection of an adequate method as well as on the surgeon's skill and practice (GLAZE, 2013). To ensure long-term treatment success, primary diseases like allergies or keratinization disorders must be addressed.

Tab. 5 *Examples of common surgical techniques for therapy of otitis externa (GLAZE, 2013)*

Bulla osteotomy	**Total ear canal ablation & bulla osteotomy**	**Vertical ear canal ablation**	**lateral ear canal resection**
Indications: • Otitis media	Indications: • End-stage otitis externa and media	Indications: • Proliferative lesions of vertical canal • poor epithelial migration of vertical canal	Indications: • Proliferative lesions of vertical canal • poor epithelial migration of vertical canal
Complications: • Hearing loss	Complications: • Hearing loss • Deafness	Complications: • Dehiscence • Stenosis of orifice	Complications: • Dehiscence • Contracture • Stenosis of orifice
Advantages: • May save hearing • lower risk of facial nerve damage	Advantages: • High success rate • minimal need for further therapy	Advantages: • eliminating much diseased tissue • less primary diseased tissue left	Advantages: • easy surgery • low complication potential • no affection of hearing

It should be emphasized that pain management is an important part of the otitis treatment and should be properly addressed (GLAZE, 2013). Negative and stressful previous experiences due to painful manipulation often make further otic examinations impossible and should be avoided (Hellyer et al., 2007).

2.3.3 Otitis Media

2.3.3.1 Pathogenesis

Otitis media can be primary or secondary. Formation of a secondary otitis media occurs due to hematogenous spread, ascending of infections through the Eustachian tube or through extension of otitis externa via a ruptured tympanic membrane. Ruptures of the tympanic membrane can develop from penetration of foreign bodies, trauma, masses or inflammations (AUGUST, 1988). The prevalence of chronic otitis externa with concurrent otitis media was as high as 80 % (COLE et al., 1998).

The majority of canine middle ear diseases are of bacterial origin, while fungal or yeast infections occur only occasionally (AUGUST, 1988).

Inflammations of the middle ear lead not only to epithelial changes but also to an increased number of glands and secretory cells. Therefore, the synthesis of exudate increases. In chronic cases, the inflammation can cause the formation of granulation tissue, ulceration, oedema and even osteomyelitis. Exudate from the middle ear can induce aural efflux and prevents the tympanic membrane from healing (GOTTHELF, 2004).

2.3.3.2 Clinical Signs

Common clinical signs of otitis media are similar to those of otitis externa and include signs of pain and discomfort like spontaneous vocalization, head tilt and head shaking. Hearing can also be impaired or lost (COLE, 2012). Depending on the involvement of the inner ear, facial nerve or the sympathetic trunk patients can show further neurologic symptoms. Common neurologic deficiencies are vestibular signs, like head tilt and nystagmus, Horner’s syndrome and facial paralysis (STURGES et al., 2006).

2.3.3.3 Diagnosis

Suspicion of otitis media is often based on the otoscopic appearance observed when using handheld otoscopes, although the tympanic membrane is better visualized after ear canal flushing and video-otoscopy. This method enables the examination of the tympanic membrane and therefore the detection of bulging, color changes or ruptures, especially in chronically changed ear canals.

Myringotomy can be performed in cases with intact tympanic membrane, allowing exudates to drain. Importantly, this method also allows for the collection of samples for cytology and bacterial cultures from the middle ear cavity (GLAZE, 2013; CLASSEN et al. 2016).

Diagnostic imaging methods like computed tomography (CT) or magnetic resonance imaging (MRI) are very useful diagnostic options for the detection of middle or inner ear involvement (DVIR et al. 2000; ROHLEDER et al., 2006) and are used to identify involved structures and determine whether filling of the tympanic cavity is of tissue or fluid origin (GOTTHELF, 2004).

2.3.3.4 Therapy

A fundamental part of the treatment of otitis media is removal of the abnormal content from the bulla tympanica via flushing and suctioning in general anesthesia (GORTEL, 2004; MORRIS, 2004).

Antimicrobials and glucocorticoids can be administered topically via infusion to the bulla tympanica or even systemically. According to some authors, a combination of topical and systemic treatment leads to the best results (GOTTHELF, 2004).

Surgical treatment, for instance total ear canal ablation with lateral or ventral bulla osteotomy, is an effective option in case of failure of conservative therapy (BRASS, 1999; EISENMENGER, 1999).

3 Materials and Methods

Dogs with unilateral and bilateral otitis externa presented from July 2010 to July 2017 at the Clinical Unit of the Internal Medicine Small Animals of Vetmeduni Vienna and in the NOA ("Notambulanz" = small animal emergency room of the Vetmeduni Vienna) were included in this retrospective analysis.

The data was taken from the "Tierspitalinformationssystem" (TIS), the medical practice management software of the Animal Hospital of the Vetmeduni Vienna. The keywords and their combinations utilized to filter relevant cases from TIS are listed in **Tab. 6**. The keywords are in German and Austrian German, because medical records in the TIS are made predominantly in German language.

Tab. 6 *List of keywords and their combinations to filter relevant patient data of the TIS of Vetmeduni Vienna*

German/ Austrian German keywords	English translation	Explanations
Otitis	otitis	
Fremdkörper, Ohr	foreign body, ear	
Fremdkörper, Otitis	foreign body, otitis	
FK, Ohr	FB, ear	*FK* is a common, German abbreviation for foreign bodies
FK, Otitis	FB, otitis	
Granne, Ohr	awn, ear	
Granne, Otitis	awn, otitis	
Mäusegerste, Ohr	wall barley, ear	
Mäusegerste, Otitis	wall barley, otitis	
Schliafhansel, Ohr	awn, ear	*Schliafhansel* or *Schliafhansl* are common Austrian German words for awn
Schliafhansel, Otitis	awn, otitis	
Schliafhansl, Ohr	awn, ear	
Schliafhansl, Otitis	awn, otitis	
Gras, Ohr	grass, ear	
Gras, Otitis	grass, otitis	
Pflanze, Ohr	plant, ear	
Pflanze, Otitis	plant, otitis	

Patients:

Dogs of different breeds and crossbreeds with otitis externa, with or without foreign body involvement, were included. The presence of foreign bodies was determined using either a handheld otoscope or via a video-otoscope and verified once the foreign body was removed. The cases were divided into two groups. Patients without the presence of foreign bodies were listed in group A, while cases with foreign body associated otitis were included in group B.

Group A:

Group A is comprised of all cases with diagnosed otitis externa in one or both ears but without signs of foreign body association. Each presentation was counted as one case, regardless of unilateral or bilateral otitis externa. Patients with two or more independent episodes of otitis were counted repeatedly. For this purpose, a new episode was counted if it occurred at least three months after the previous one. This “three-month interval” was selected to prevent inclusion of rechecks and patients with otitis treatment failure.

Group B:

All cases with at least one foreign body in one or both ear canals were counted in this group. According to the medical records signs of ear canal inflammation were absent or at least not described in some patients with foreign bodies. Using the same method as in group A, if the same patient presented with a new ear problem repeatedly, it was counted as a “new case”, as long as the foreign body was completely removed during the previous presentation. Patients presented with multiple foreign bodies in one or both ear canals were counted as one case. Only patients with confirmed foreign bodies were included. Patients with otitis signs in both ear canals but only a unilateral foreign body were counted in this group.

Ear shape, breed, age at presentation and gender of all cases were evaluated retrospectively based on the data from the medical records database (TIS).

Regarding the ear shape, patients were, based on another study, allocated into three categories according to their ear shapes (HUANG and HUANG, 1999):

- **Erect ears (EE)**
- **Tilt ears (TE)**
- **Pendulous ears (PE)**

Although Huang described ear shapes as follows: erect ears, semierect ears and pendulous ears.

In this study, EE were defined as protruding pinnae from base to apex. In this case, the inner side of the pinna can be seen from the front and lateral aspect, unless ear or head hairiness mask the field of vision.

Tilt ears correspond to semierect ears and were characterized as protruding pinnae around their bases with tilted apex regions. The inside of the pinnae can be seen partially, unless ear or head hairs mask the field of vision.

PE were classified as pendulous pinnae from base to apex. The inside of the pinnae cannot be seen without lifting up the pinnae.

Fig. 2 shows examples for each category.

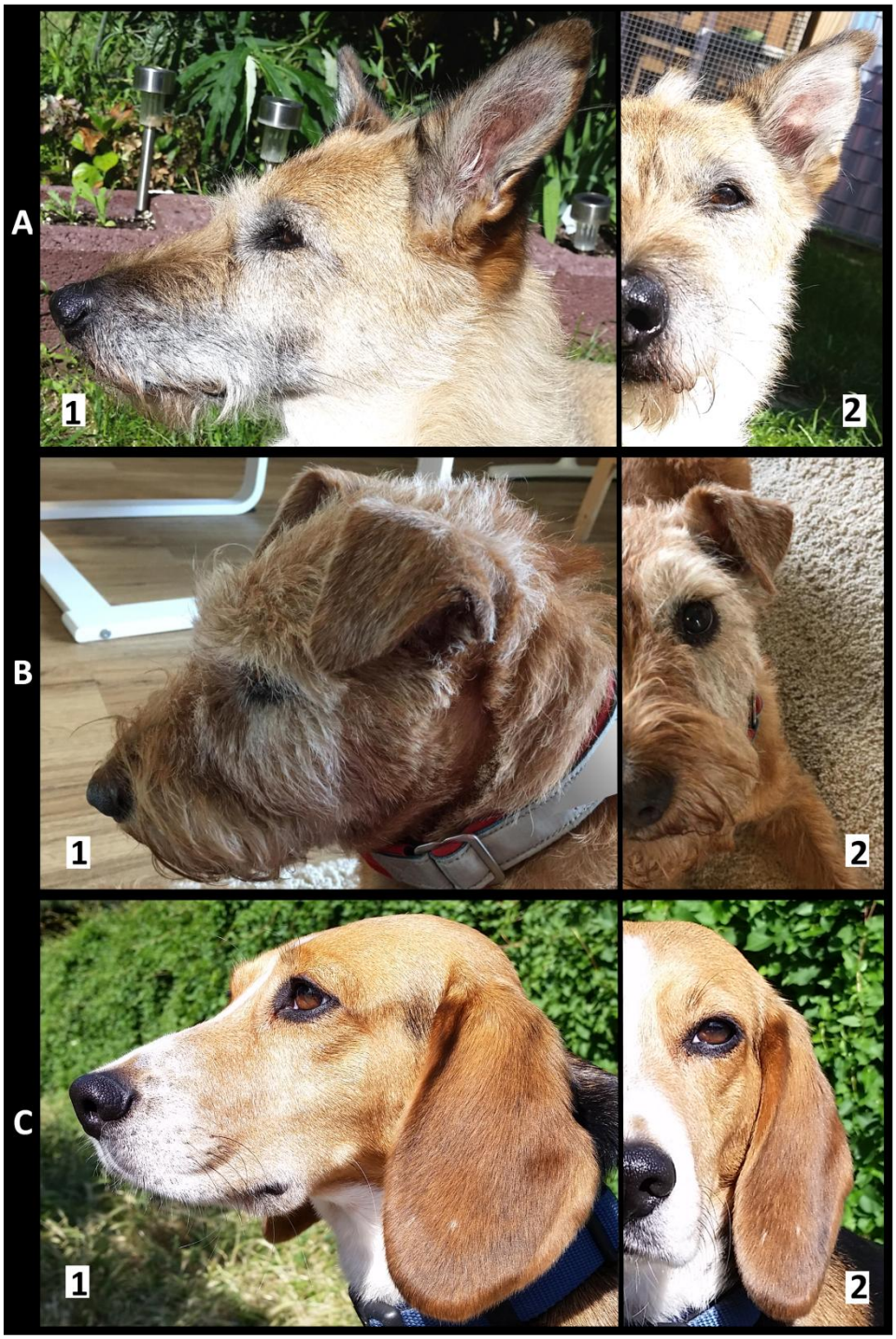

Fig. 2 *Examples of ear shape categories*

A = EE – erect ears (breed: Crossbreed);

B = TE – tilt ears (breed: Irish Terrier);

C = PE – pendulous ears (breed: Beagle);

1 = lateral view; 2 = frontal view

Source: Marc Tritsch

All of the ear shapes of the purebred cases were classified according to the breed standards of the Fédération Cynologique Internationale (FCI) or, in the case of non FCI recognized breeds, by the standards of the Kennel Club (KC) or the American Kennel Club (AKC).

Tab. 7 in the **annex** shows the complete list of breed specific ear shape categorization from this study.

For the crossbreeds and dogs of unknown breed, the ear shape was assessed based on a questionnaire and via a phone call interview or email to the dog owner.

Statistical analysis

Statistical evaluation was performed with the software programs “IBM SPSS v24” and “GNU PSPP 0.10.2”.

The ear shape parameter and breed were evaluated by calculation of the relative frequencies of foreign body cases to the total number of otitis cases. The distribution was evaluated using the chi-squared test. The statistical significance was defined as $p < 0.05$.

Calculation of relative gender frequencies of foreign body cases in the total number of otitis-cases was performed and the distribution was evaluated using the chi-squared test with a defined statistical significance of $p < 0.05$.

The age at the presentation was calculated by logistic regression with a defined statistical significance of $p < 0.05$.

4 Results

According to the medical records, a total of 1141 cases of dogs with unilateral or bilateral otitis externa were presented in the investigation period. 919 of these cases were purebreds of 106 different breeds. 187 cases were crossbreeds and in 35 cases the breed was unknown.
Tab. 7 in the **annex** lists all 106 canine breeds represented in this study in alphabetical order.

In this study, the four canine breeds that were most represented were Labrador Retrievers with 78 cases, Golden Retrievers with 74 cases, English Cocker Spaniels with 73 cases and French Bulldogs with 45 cases.

As can be seen in **Tab. 8**, of a total of 1141 cases, 985 (86.3 %) were added to Group A, while the remaining 156 cases were included in Group B, making up 13.7 %.

Tab. 8 *Frequency of FB associated otitis of all 1141 cases*

	Amount	Percentage
Group A	985	86.3
Group B	156	13.7
total	1141	100.0

Relationship of the ear shape and foreign body associated ear disease:
From 222 crossbreeds and dogs of unknown breed, the ear shape of 23 dogs could be determined via phone call interview or email to the owner. In the remaining 199 cases of crossbreeds and dogs of unknown breed, the shape of the ear could not be assessed because the owners could not be contacted.
Therefore, these 199 “unknown” cases were not involved in further ear shape and breed analysis.

Of the 942 cases with available ear shape type, 214 cases (22.7 %) had the EE ear shape type, 143 cases (15.2 %) were assigned to the TE ear shape type and 585 cases (62.1 %) were categorized as PE ear shape types.

Tab. 9 lists the ear shape frequencies of the 942 cases with known ear shape type.

Tab. 9 *Ear shape frequencies of cases with available ear shape type*

Ear shape	Amount	Percentage
EE	214	22.7
TE	143	15.2
PE	585	62.1
Total	942	100.0

The analysis of the ear shape parameter, as illustrated by **Tab. 10**, displays a homogeneous distribution of relative frequencies of foreign body associated otitis, with the TE group showing the highest relative frequency with 18.2 % (26/143 TE-cases), compared to the PE group with 14.2 % (83/585 PE-cases) and the EE group with the lowest relative frequency of 12.6 % (27/214 EE-cases). The average relative frequency of all 942 cases is 14.4 % (136/942 cases). Given that the belonging **p-value = 0.328**, this is not significant.

Tab. 10 *Ear shape crosstabulation*

Ear shape		Group A (no FB)	Group B (FB)	*total*
EE	Amount	187	27	214
	Percent	87.4	12.6	100.0
TE	Amount	117	26	143
	Percent	81.8	18.2	100.0
PE	Amount	502	83	585
	Percent	85.8	14.2	100.0
total	Amount	806	136	942
	Percent	85.6	14.4	100.0

Relationship of breed and foreign body associated ear disease:

The evaluation of breeds and breed groups with more than eight cases in the investigated period showed that Spaniel-breeds and Russell Terriers (Jack Russell Terrier and Parson Russell Terrier) had significantly higher relative frequencies of foreign body associated otitis.

Spaniel-breeds accounted for 124 cases in the investigated period and showed a relative frequency of foreign body associated otitis of 29.84 % (37/124 Spaniel-cases), with the **p-value = 0.00.** In comparison to 12.10 % (99/818 cases) of the remaining 818 cases, this was significant.

Tab. 11 depicts these results.

Tab. 11 *FB associated otitis frequency evaluation crosstabulation of Spaniel-breeds compared to all other cases*

Breed		**Group A (no FB)**	**Group B (FB)**	***total***
Other (total minus Spaniel-breeds)	Amount	719	99	818
	Percent	87.90	12.10	100.0
Spaniel-breeds	Amount	87	37	124
	Percent	70.16	29.84	100.0
Total	Amount	806	136	942
	Percent	85.56	14.44	100.0

Russell Terriers represented 10 cases with a relative frequency of foreign body associated otitis of 40 % (4/10 Russell Terrier-cases). According a **p-value = 0.021** this is significantly higher than the relative frequency of the remaining 932 non-Russell Terriers with 14.16 % (132/932 cases).

The results of the Russell Terriers are shown in **Tab. 12**.

Tab. 12 *FB associated otitis frequency evaluation crosstabulation of Russell Terriers compared to all other cases*

Breed		**Group A (no FB)**	**Group B (FB)**	***total***
Other (total minus Russell Terriers)	Amount	800	132	932
	Percent	85.84	14.16	100.0
Russell Terriers	Amount	6	4	10
	Percent	60.00	40.00	100.0
Total	Amount	806	136	942
	Percent	85.56	14.44	100.0

Gender:

For the evaluation of the gender parameter, gender data of all 1141 otitis cases was provided by TIS, with **Tab. 13** showing the gender frequencies in this study.

Of the total 1141 cases, 314 (27.5 %) were males (M), 236 (20.7 %) were castrated males (MC), 259 (22.7 %) were females (F) and 332 (29.1 %) were spayed females (FS).

Tab. 13 *Gender frequencies*

Gender	Amount	Percentage
M	314	27.5
MC	236	20.7
F	259	22.7
FS	332	29.1
total	1141	100.0

The corresponding evaluation of the connection between gender and foreign body associated otitis, depicts a relatively homogenous distribution, with an average relative frequency of foreign body associated otitis of 13.7 % (156/1141 cases), illustrated by the belonging crosstabulation **Tab. 14**.

FS showed the highest relative frequency with 16.3 % (54/332 cases), while MC showed the lowest relative frequency with 11.4 % (27/236 cases) of foreign body associated ear disease. The relative frequency of M corresponds to the average with 13.7 % (43/314 cases) and F had a relative frequency below the average with 12.4 % (32/259). Given that **p-value = 0.352**, this is not significant.

Tab. 14 *Gender parameter crosstabulation of all 1141 cases*

Gender		Group A (no FB)	Group B (FB)	*total*
M	Amount	271	43	314
	Percent	86.3	13.7	100.0
MC	Amount	209	27	236
	Percent	88.6	11.4	100.0
F	Amount	227	32	259
	Percent	87.6	12.4	100.0
FC	Amount	278	54	332
	Percent	83.7	16.3	100.0
total	Amount	985	156	1141
	Percent	86.3	13.7	100.0

Age:

Data on patients' ages was available in 1136 cases, ranging from two and a half months to 17 years, while in five cases the age was unknown. The patients' average age at the time of presentation of the 1136 cases was 6.37 years.

The distribution of the age at presentation is demonstrated in **Fig. 3**.

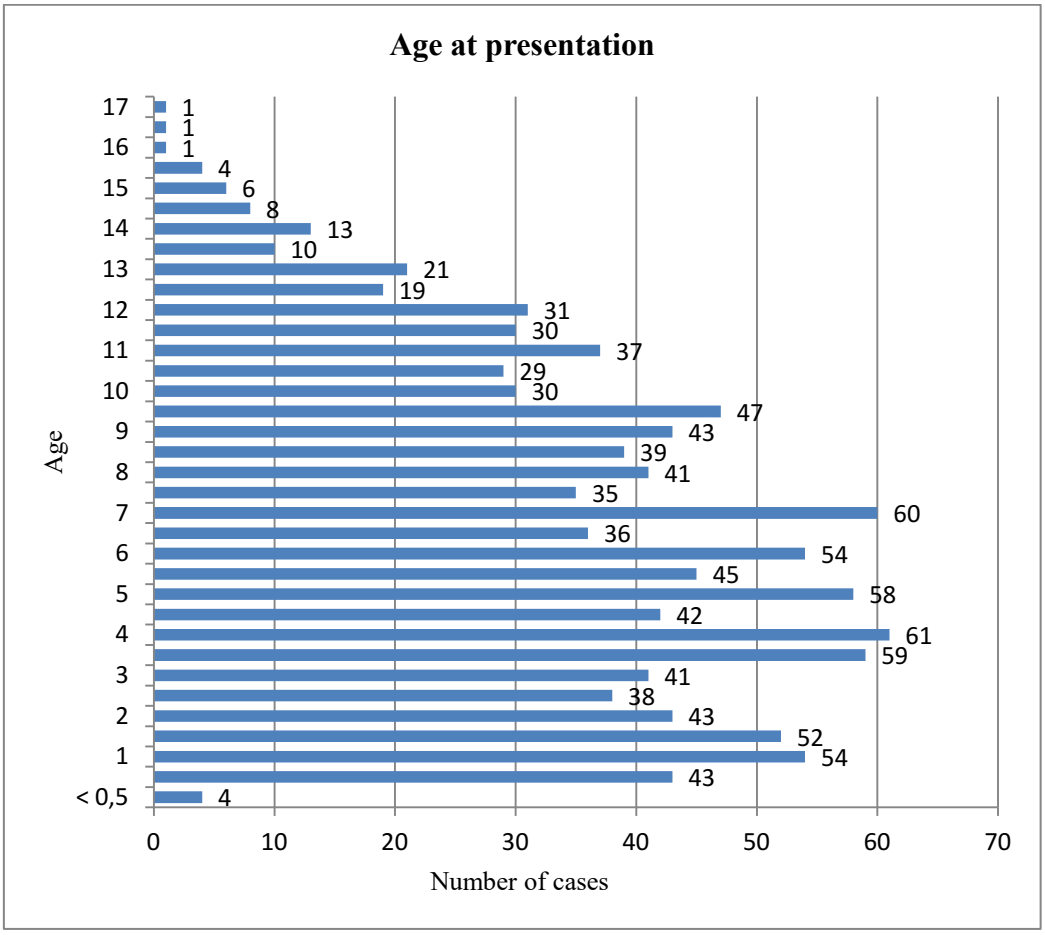

Fig. 3 *Distribution of age at presentation*

Based on the statistical analysis, young dogs were more prone to foreign body associated otitis, with a likelihood of approximately 20 % in dogs that were less than 6 months old. Based on our results, the probability of foreign body associated otitis decreases exponentially with growing age and is lowest in old dogs, with a likelihood of approximately 6 % in dogs of 17 years. According a **p-value = 0.001**, this is significant. **Fig. 4** illustrates the probability of the occurrence of foreign body associated otitis as a function of age with the corresponding exponential trendline.

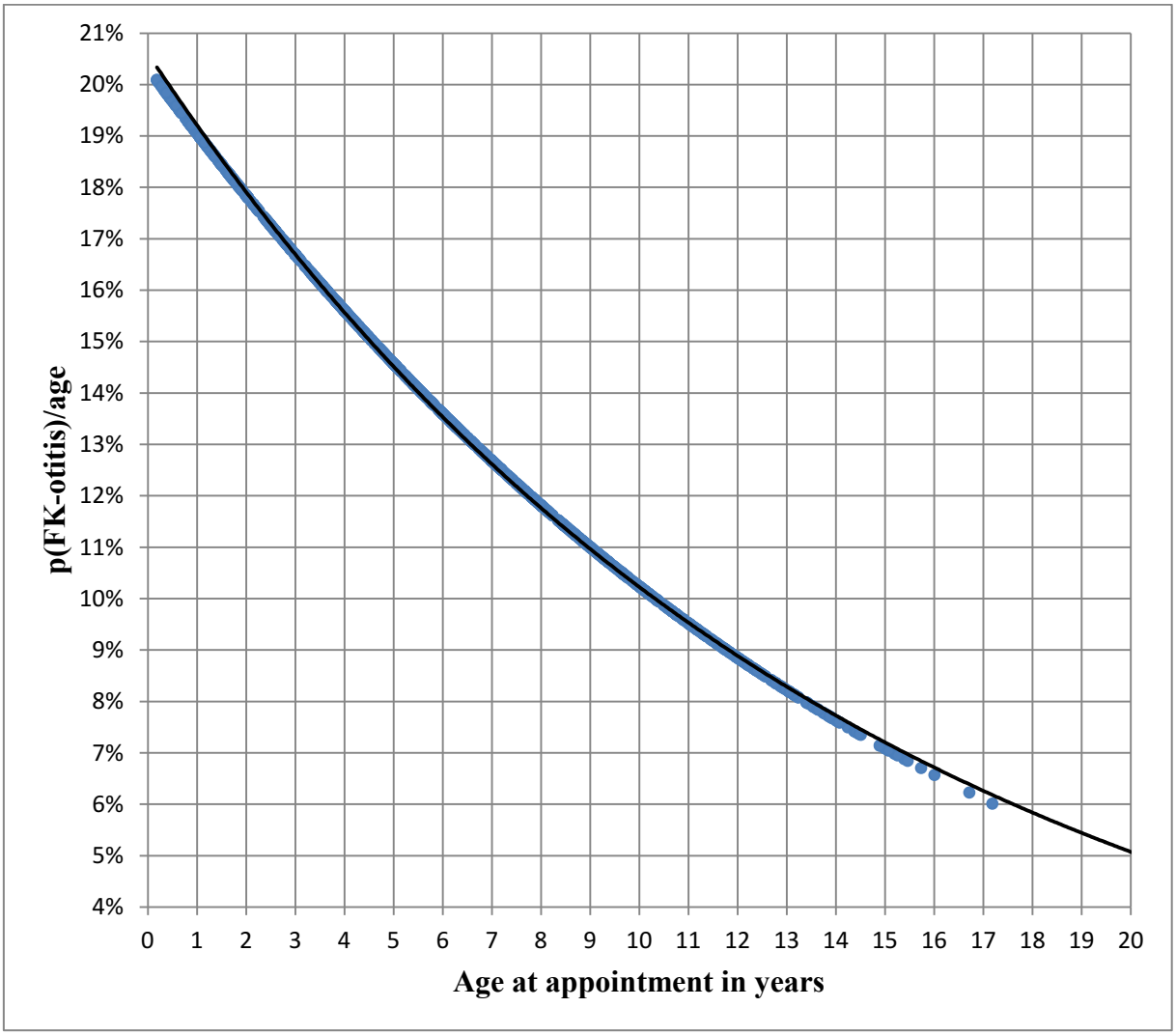

Fig. 4 *FB associated otitis probability as a function of age*

Blue: probability data of the 1136 cases

Black: corresponding exponential trendline (y = 0,206e^(-0,07x))

5 Discussion

For this retrospective study, data from 1141 canine cases with unilateral or bilateral otitis externa was evaluated. Both acute and chronic otitis cases were included. If the same patients were presented due to multiple independent otitis episodes, each episode was counted as a new case.
The main focus of this study, foreign body associated otitis externa, was diagnosed in 156 of the total 1141 (13.7 %) otitis cases.
One of the aims of this study was to determine whether anatomical characteristics of the canine ear predispose patients to foreign body associated otitis externa. Furthermore, the author has evaluated if other parameters, such as gender, age or breed, have any influence on the incidence of foreign body associated otitis externa.

There are several additional parameters, such as ear canal hairiness, coat type on the pinnae and head in general, grooming of the ear canal, ear canal diameter, size of the dog, keeping/housing conditions and lifestyle/usage of the dog, that might have further impact on the occurrence of foreign body associated otitis. Due to the retrospective design of the study these issues could not be addressed precisely, so no further analysis was performed.
Foreign body associated ear disease is an unpleasant, rather common condition, making up 13.7 % of all otitis cases in this study, which can lead to chronic otitis externa and even otitis media, if it stays unrecognized. There is very limited published data on risk factors for foreign body associated ear disease. Therefore, closer analysis of this problem was performed.

In general, foreign body associated diseases present a common and often serious to life threatening problem in the everyday small animal veterinary practice. There are many different types of foreign bodies, with grass awns being the most common (PLICKERT et al., 2014; TETAS PONT et al., 2016; FRENDIN et al., 1999), as well as other objects of plant origin, such as wood particles, thorns and grass blades (TETAS PONT et al., 2016; ARMBRUST et al., 2003; JONES and OBER, 2007). However, stones, sand, or even metal pins (PLICKERT et al., 2014; TETAS PONT et al., 2016; LOBETTI, 2009) can be found stabbed in nearly all body regions or openings. Multiple publications analyzing canine

health issues related to foreign bodies in different areas, for example nasal cavity, other soft tissues and skin, eye and periorbital region, urinary bladder and even in the spinal cord or central nervous system (HICKS et al., 2016; BUSSANICH and ROOTMAN, 1981; CHERBINSKY et al., 2010; LINON et al., 2014; DENNIS et al., 2005) were discovered by the author during his active search on this topic. Some foreign bodies, such as grass awns, can penetrate skin and nearly all tissues with their sharp ends or barb-like spikelets and then migrate unidirectionally. In this way they can be detected in remote areas (MARCHEGIANI et al., 2017; ARMBRUST et al., 2003; FRENDIN et al., 1999).

Clinical signs can differ noticeably, dependent on the location. They usually start with acute signs, which can later become chronic and change into unspecific signs (MELER et al., 2008). Concerning foreign bodies in the nasal cavity common signs vary from sneezing, snorting, head-shaking and epistaxis to for example hemorrhagic-purulent discharge (TASKER et al., 1999; VANSTEENKISTE et al., 2014). In the periorbital region, foreign bodies can cause different clinical signs like swelling, pain, ocular discharge, abscess formation and exophthalmus (MARCHEGIANI et al., 2017; HARTLEY et al., 2007), while foreign bodies in the eyeball can cause severe inflammation of the iris and ciliary body (BUSSANICH and ROOTMAN, 1981). Foreign bodies can also migrate through the openings of the genitourinary tract and cause soft tissue inflammation or chronic discharge (CHERBINSKY et al., 2010).

If located in other soft tissues or subcutaneously, such as the mandibular region, axillary region, or the thoracic or abdominal wall region, they can result in pain, reduced movement of the affected region, swelling, subcutaneous granulomas or abscesses and discharge through draining tracts (HOYT et al., 2009; DELLA SANTA et al., 2008; VANSTEENKISTE et al., 2014). Interdigital web abscesses can be caused by for instance foreign bodies of plant origin in dogs.

As a result deep infections, abscesses and draining tracts must be treated surgically and often, due to the migration, detection may be very difficult.

Foreign bodies can be detected with different methods, such as endoscopy or diagnostic imaging methods like ultrasonography (US), CT or MRI (MELER et al., 2008;

OBER et al., 2008), dependent on their radioopacity, location, chronicity of the process and the skills of the veterinarian.
Ober has evaluated three diagnostic imaging methods, US, CT and MRI, in their ability to detect 30 wooden foreign bodies located in the interdigital area. CT was most successful in the detection of foreign bodies all over the whole paw, followed by US, being the most limited method in the area around the metacarpal pad. Surprisingly, MRI has shown the weakest results in general (OBER et al., 2008). In another study, of 13 foreign bodies of predominantly plant origin, but also one metal needle, located in the nasal cavity, thoracic wall, central nervous system and retropharyngeal region, only eight (61.5 %) could be identified via CT (JONES and OBER, 2007).

Hicks et al. have studied grass seed foreign body associated diseases and their risk factors in dogs in rural Australia. Their study analyzed foreign bodies in general. The study evaluated data from 473 dogs from two Australian veterinary clinics retrospectively with a five year investigation period (2006 to 2011). In general practice foreign body associated otitis showed to be the most common foreign body disease, making up 47 % of all foreign body diseases (HICKS et al., 2016).
In contrast, our retrospective study focused solely on foreign body associated cases of otitis, with 156 foreign body associated otitis cases from a total of 1141 otitis cases (13.67 %) in a seven-year investigation period (2010 to 2017).

Other than Hicks, no additional publications dealing with the risks of foreign bodies, otitis externa and potential predisposing factors were found by the time of finishing this diploma thesis, making this study the first of its kind.

Interestingly, even though otitis externa is common in cats, this species does not seem to have foreign body associated otitis. Cases of feline foreign body associated otitis were not found in this study, even though the keywords chosen to filter relevant data from the TIS were not species specific, and they were also not found in other studies examining foreign body diseases in cats (VANSTEENKISTE et al., 2014). Therefore, the authors of this study made no further investigation into foreign body associated otitis in cats.

Predisposing factors, which increase the risk of foreign bodies becoming lodged in the external ear canals and therefore raise the frequency of patients becoming presented to a veterinarian, do have two approaches to unfold their impact:
On the one hand, regional predisposing factors can hinder spontaneous, unassisted removal of entrapped foreign bodies through for example headshaking and ear scratching.
On the other hand, predisposing factors can increase the number of foreign bodies reaching the external ear canal of dogs and therefore also increase the total number of foreign bodies becoming trapped in a way that hinders affected dogs from removing them without assistance, even though the ratio of removable and unremovable foreign bodies stays constant.

Considering the ear shape, this study could not reveal a significant difference in the incidence of foreign body associated otitis among all countable cases. Based on our results, ear shape does not have any significant influence.
However, with the analysis of breeds and breed-groups, we have shown that Spaniel-breeds, with pendulous pinnae, and Russell Terriers, with tilted pinnae, have significantly (Spaniel-breeds: p-value = 0.00; Russel Terriers: p-value = 0.021) higher frequencies of otitis due to foreign bodies than other breeds. However, Russell Terrier cases made up only ten of all 1141 cases (0.87 %), while Spaniel-breeds accounted for 124 (10.87 %) of all 1141 otitis cases.
Regarding Spaniel-breeds, this finding corresponds with two other studies. The study of SARIDOMICHELAKIS et al., which focused on the etiology of canine otitis externa, has shown higher frequencies of foreign body otitis externa in Cocker Spaniels (SARIDOMICHELAKIS et al., 2007) and HICKS et al., who investigated grass seed associated foreign body diseases in dogs in Australia, also found an increased prevalence of foreign body disease in Spaniels, but also in Border Collies, Staffordshire Terriers, Golden Retrievers, Australian Kelpies, Labrador Retrievers and Shi Tzu (HICKS et al., 2016). Increased prevalence of foreign body associated otitis externa among the other mentioned breeds was not observed in our study.
Our results show that certain breeds with pendulous and tilted pinnae seem to be predisposed, so additional factors or their combinations may play a role.

Furthermore, the following characteristics could additionally be taken into consideration as possible predisposing factors by themselves or in combination with the shape of the pinnae: diameter of the external ear canal, amount of hair-growth in the external ear canal, hair-growth of the pinna, hair-growth of the head, size of the dog, frequency of grooming by the owner, housing conditions like indoor/outdoor housing and the use of the dog such as for hunting or herding.

Marked disparities in the mean diameters of external ear canals between different breeds exist and there is a positive correlation between body weight and external ear canal diameter (EOM et al., 2000; HUANG et al., 2009). It is hypothesized that a narrow ear canal might provide more contact surface for the spikelets of grass awns and therefore impedes shaking them out. This could allow further migration into deeper parts of the ear canal.

Moreover, external ear canals of Spaniel-breeds are classified in numerous studies as hirsute, when compared to other breeds (HUANG and HUANG, 1999; STOUT-GRAHAM et al., 1990; HAYES et al., 1987). This supports the theory that hairy ear canals predispose breeds for foreign body associated otitis. This may be through trapping of foreign bodies in the ear canal hairs and therefore decreased rate of autonomous removal. Interestingly, in our study poodles, also known for their hirsute ear canals and pendulous pinnae, did not show a significantly higher prevalence of foreign body associated otitis externa in comparison to other breeds.

Type and amount of haircoat on the pinnae and head are part of the breed specific standards determined by cynologic organizations like FCI, KC or AKC. According to these definitions, the pinnae of Cocker Spaniels are categorized as hirsute in one publication (PATERSON, 2016), but because of common owner practices like seasonal coat trimming and haircutting due to fashion reasons, the hair-growth on the pinnae and head are retrospectively immeasurable parameters. It can be hypothesized that a certain haircoat on the head and pinnae could prevent foreign bodies from reaching the ear canal because they become lodged in the coat or, on the contrary, may increase the risk of collecting foreign bodies like grass awns in the fur with subsequent migration into the ear canal.

HICKS et al. identified “medium-coat dogs” to have the most statistically significant rate of any foreign body related disease (HICKS et al., 2016).
The same study has also shown that “weekly to monthly grooming” by the owner was associated with reduced occurrence of foreign body associated disorders (HICKS et al., 2016). This was not evaluated in our retrospective study.

Size, especially shoulder height, of the dog could be another factor that influences the risk of plant awns reaching the external ear canals of dogs. Similar levels of pinnae and height of plant growth of, for example foxtails, might raise the risk of foreign bodies reaching the ear canals, while pinnae levels below or above plant growth levels may lead to lower or unaltered risks.

Concerning the fact that most foreign bodies are of natural origin, housing conditions may have an impact on the occurrence of foreign body associated otitis. Dogs spending a lot of time outside in nature, like hunting dogs or herding dogs, are exposed to a higher foreign body pressure than pet dogs, which spend more time indoors, and could therefore have a higher risk of foreign body associated otitis. Two recent studies concluded that hunting and working dogs are predisposed to foreign body associated traumatic disease. One study analyzed ophthalmic foreign bodies and the other looked at foreign body related diseases in general (TETAS PONT et al., 2016; HICKS et al., 2016). Due to the retrospective character of our study, the relationship between the lifestyle, use and size of the dog and foreign body associated otitis externa could not be evaluated.

Our study did not reveal any significant difference in gender or castration status on the occurrence of foreign body associated otitis when comparing all countable cases. The cases were categorized as male, male castrated, female and female spayed. Analysis showed a relatively homogenous distribution, but it should be mentioned that the castration records provided by the medical records database (TIS) solely represent the status at the time of analysis of this study, not at the time of diagnosis, since using the TIS only the last entered castration information can be derived, which does not necessarily correspond with the actual status during the presentation due to otitis or a foreign body in the investigated period.

Nevertheless, the finding conforms to the authors' initial assumption that gender/sexual hormones do not influence the incidence of foreign body associated otitis. It also corresponds to another study analyzing risk factors of foreign body related eye disease, which did not reveal any relationship between foreign body trauma and gender (TETAS PONT et al., 2016).

According to our results a negative correlation of foreign body associated otitis externa with the age of the patient was found, making young dogs the most high-risk category of all patients. This result matches with the similar study from TETAS PONT et al., who has shown that dogs under five years had a significantly higher risk of getting foreign body associated eye diseases if compared with dogs older than five years (TETAS PONT et al., 2016). This might be because of different behavioral profiles and movement activities of young and aged dogs.

A study from 1997 illustrated that there is no general correlation between the age and the movement of dogs, but a breed dependent correlation appears to exist. The authors have shown that the activity of beagles in an open space did not differ among different age groups, while the open space activity of dogs from a shelter decreased with age (HEAD et al., 1997).

Another study, dealing with exercise activities in different age groups has shown that "young" and "unimpaired aged" beagles showed similar behavior profiles, but "unimpaired aged" dogs with less extent and less moving activity in an open field. "Impaired aged" beagles showed similar movement activity in an open field, compared to "young" dogs, but with a different behavior profile, consisting of much more random and undirected behavior patterns (SIWAK et al., 2001).

High mobility combined with playing and exploration behavior patterns like sniffing, especially in natural landscapes, could probably also lead to higher risks of getting foreign bodies trapped in the external ear canals.

In summary, according to our results ear shape and gender did not have a significant influence on the occurrence of foreign body induced otitis externa in dogs, whereas a significant correlation was found between the breed and age at presentation.

Due to the limitations of this retrospective study, several eligible characteristics, like ear canal hairiness, coat type on the pinnae and head in general, grooming of the ear canal, ear canal diameter, size of the dog, keeping/housing conditions and lifestyle/usage of the dog, could not be examined. Therefore, the author would recommend the implementation of a subsequent prospective study covering more or at least different characteristics than in this study.

6 Summary

The aim of this retrospective cohort study was to find out if characteristics like ear shape, breed, gender and age have a predisposing influence on the occurrence of foreign body associated otitis externa.
To achieve this, 1141 cases of patients with diagnosed otitis externa, which were introduced at the *Clinical Unit of the Internal Medicine Small Animals* and *NOA ("Notfallambulanz" = small animals emergency room)* of the Vetmeduni Vienna in the time from July 2010 to July 2017, were evaluated.
156 of 1141 cases were foreign body associated cases of otitis externa.

To evaluate the ear shape parameter, the cases were grouped as "erect ears", "tilt ears" and "pendulous ears". Statistical analysis showed no significant correlation between ear shape and the frequency of otitis due to foreign bodies.

Breed analysis showed that Spaniel-breeds (pendulous ears) and Russell Terriers (tilt ears) had significantly higher risks of presenting with foreign body associated otitis.

Analysis of gender, with classifications of "male", "male castrated", "female" and "female spayed", showed no correlation between gender and the occurrence of foreign body associated otitis.

The age at presentation of the investigated cases varied from under six months to 17 years, with an average of 6.37 years.
Statistical analysis showed that there is a significant decrease of the probability of presenting with foreign body associated otitis with increasing age.

7 Zusammenfassung

Ziel dieser retrospektiven Studie war es herauszufinden, ob es einen prädisponierenden Einfluss durch bestimmte Eigenschaften wie Ohrform, Rasse, Geschlecht und Alter auf das Auftreten von Fremdkörper assoziierter Otitis Externa gibt.
Dazu wurden 1141 Fälle von Patienten mit diagnostizierter Otitis Externa, welche an der *Universitätsklinik für Interne Medizin Kleintiere* und an der *Kleintier Notambulanz* der Veterinärmedizinischen Universität Wien im Zeitraum von Juli 2010 bis Juli 2017 vorstellig wurden, untersucht.
156 von 1141 Fällen waren Fälle mit Fremdkörper assoziierter Otitis Externa.

Bezüglich der Ohrform wurden die Fälle in „Stehohren“, „Kippohren“ und „Hängeohren“ eingeteilt. Die statistische Analyse zeigte, dass es keinen signifikanten Zusammenhang zwischen Ohrform und der Häufigkeit von Otitis durch Fremdkörper gibt.

Die Analyse bezüglich Rasse zeigte, dass Spaniels (Hängeohren) und Russel Terrier (Kippohren) ein signifikant höheres Risiko haben an Fremdkörper assoziierter Otitis zu erkranken.

Die Untersuchung des Geschlechts, mit Einteilung in „männlich“, „männlich kastriert“, „weiblich“ und „weiblich kastriert“, ergab, dass es keinen Zusammenhang zwischen Geschlecht und dem Auftreten von Fremdkörper assoziierter Otitis gibt.

Das Alter bei Vorstellung der untersuchten Fälle variierte von unter einem halben Jahr bis 17 Jahren, mit einem Durchschnitt von 6,37 Jahren.
Die statistische Analyse zeigte, dass die Wahrscheinlichkeit des Auftretens von Fremdkörper assoziierter Otitis mit steigendem Alter signifikant abnimmt.

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9 Annexe

9.1 Appended Tables

Tab. 7 *List of breed specific ear shape categorization for this study*

PE + red = pendulous ear,

TE + green = tilt ear,

EE + blue = erect ear

Breed	Ear shape
Akita	EE
Alaskan Malamute	EE
American Bulldog	TE
American Cocker Spaniel	PE
American Pit Bull Terrier	TE
American Staffordshire Terrier	TE
Australian Cattle Dog	EE
Australian Kelpie	EE
Australian Shepherd	TE
Austrian Black and Tan Hound	PE
Bavarian Mountain Scent Hound	PE
Beagle	PE
Bearded Collie	PE
Belgian Shepherd Dog	EE
Berger de Brie	PE
Berger de Picardie	EE
Bernese Mountain Dog	PE
Bichon Frise	PE
Bolognese	PE
Border Collie	EE
Border Terrier	PE
Boston Terrier	EE
Boxer	PE
Bulldog	TE
Bullmastiff	PE
Bull Terrier	EE
Cane Corso Italiano	PE

Cao de Água Português	PE
Cavalier King Charles Spaniel	PE
Chihuahua	EE
Chinese Crested Dog	EE
Collie Rough	TE
Dachsbracke	PE
Dachshund	PE
Dalmatian	PE
Deutsch Langhaar	PE
Dogo Argentino	PE
Dogue de Bordeaux	PE
Dutch Schapendoes	PE
English Cocker Spaniel	PE
English Setter	PE
English Springer Spaniel	PE
Entlebuch Cattle Dog	PE
Eurasian	EE
Field Spaniel	PE
Flat Coated Retriever	PE
Fox Terrier	TE
French Bulldog	EE
German Hunting Terrier	TE
German Shepherd Dog	EE
German Short-Haired Pointing Dog	PE
German Spitz	EE
German Wire-Haired Pointing Dog	PE
Giant Schnauzer	PE
Golden Retriever	PE
Gordon Setter	PE
Great Dane	PE
Havanese	PE
Hovawart	PE
Husky	EE
Irish Red Setter	PE
Irish Terrier	TE
Jack Russell Terrier	TE
Kleiner Münsterländer	PE

Kuvasz	PE
Labrador Retriever	PE
Lagotto Romagnolo	PE
Leonberger	PE
Lhasa Apso	PE
Magyar Vizsla	PE
Malinois	EE
Maltese	PE
Mastiff	PE
Mudi	EE
Nederlandse Kooikerhondje	PE
Newfoundland	PE
Old English Sheepdog	PE
Papillon Dog	EE
Parson Russell Terrier	TE
Pekingese	PE
Pinscher	TE
Poodle	PE
Posavatz Hound	PE
Pudelpointer	PE
Pug	TE
Pyrenean Mountain Dog	PE
Retriever	PE
Rhodesian Ridgeback	PE
Rottweiler	PE
Sharplanina	PE
Schnauzer	TE
Scottish Terrier	EE
Shar Pei	TE
Shetland Sheepdog	TE
Shiba	EE
Shih Tzu	PE
Siberian Husky	EE
Spaniel	PE
Staffordshire Bull Terrier	TE
St. Bernard	PE
Tibetan Spaniel	PE

Weimaraner	PE
Welsh Springer Spaniel	PE
Welsh Terrier	TE
West Highland White Terrier	EE
Yorkshire Terrier	EE

9.2 List of Tables

9.3 List of Figures

9.4 List of Abbreviations

AKC	American Kennel Club
CT	Computed tomography
EE	Erect ears
F	Female
FB	Foreign body
FCI	Fédération Cynologique Internationale
Fig.	Figure
FS	Female spayed
KC	Kennel Club
M	Male
MC	Male castrated
MRI	Magnetic resonance imaging
NOA	Notambulanz
PE	Pendulous Ears
Tab.	Table
TE	Tilt ears
TIS	Tierspitalinformationssystem
US	Ultrasonography
Vetmeduni Vienna	University of Veterinary Medicine Vienna