Low-field magnetic resonance imaging of otitis media in two cats: a case report

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ABSTRACT: Otitis media is a common disease in clinical veterinary practice. Although low-field magnetic resonance imaging reports for otitis media in dogs exist, in cats detailed information is missing. Radiography is helpful in diagnosing chronic inflammation, but may be insufficient during the initial phase of inflammation. For this reason, this report describes the magnetic resonance findings in two cats with otitis media. In both cases, middle ear empyema was detected. Magnetic resonance imaging of middle ear disorders in cats should contain pre- and post-contrast T1-weighted sequences in the dorsal and transverse planes, a T2-weighted sequence in the dorsal and transverse planes and a fluid-attenuated inversion recovery sequence in the dorsal or transverse planes. On pre-contrast T1-weighted images, the empyema had an intensity similar to that of brain tissue with a delicate hyper-intensity in the middle. On post-contrast T1-weighted images, the material had non-uniform enhancement in the dorsolateral compartment and circumference enhancement in the ventromedial compartment of the tympanic bulla with a hypo-intense centre. On T2-weighted images, the mass had heterogeneously increased signal intensity to brain tissue, but was less intense than cerebrospinal fluid. In the fluid-attenuated inversion recovery sequence, the pathological lesion was distinctly hyper-intense in comparison to other tissues with a narrow area of increased signal intensity in the middle of the ventromedial tympanic bulla compartment. Magnetic resonance imaging is commonly used for the visualisation of different disorders of the membranous labyrinth and allows the differentiation of chronic hematomas, empyemas and middle and internal ear neoplasia. The recommended magnetic resonance protocol of the middle ear should include pre- and post-contrast T1 sequences in the dorsal and transverse planes, the T2 sequence in the dorsal and transverse planes and the fluid-attenuated inversion recovery sequence in the dorsal or transverse planes.

Keywords: MRI; middle ear; tympanic bulla; empyema; feline

Otitis media is a frequent clinical problem (Remedios et al. 1991). Physical examination of ears is limited to the outer ear and the tympanic membrane (Shell 1988). The examination of the middle and internal ear is possible using such diagnostically modalities as radiology, computed tomography (CT) and magnetic resonance imaging (MRI) (Hoskinson 1993). Although radiography may be useful in diagnosing chronic inflammation, it might not be sufficient in the initial phase of inflammation. For this reason, conventional radiography is not sufficiently sensitive for the diagnosis of middle ear disorders (Remedios et al. 1991; Hoskinson 1993). MRI has replaced radiography and is the technique of choice in the diagnosis of human middle ear disease (Casselman et al. 1994). Otitis media is a common disease in clinical veterinary practice. Most frequently, otitis media appears as a result of primary inflammation of the external ear or, less commonly, due to auditory tube or haematogenous infection (Remedios et al. 1991). It is a painful disorder with severe symptoms, such as head tilting and shaking, facial paralysis or Horner’s syndrome (Shell 1988). The proper diagnosis of otitis media is based on history, clinical presentation and additional visualisation modalities (radiography, CT, MRI; Dvir et al. 2000). Computed tomography is a precise imaging modality for diagnosis of
otitis media, but is limited in its ability to exclude otitis interna or some masses affecting the vestibu- 
ulocochlear nerve (Kneissl et al. 2004). Low-field 
MRI reports for otitis media in dogs exist, but in 
cats detailed information is missing (Allgoewer et 
al. 2000; Dvir et al. 2000; Kneissl et al. 2004). This 
paper describes the MRI findings in two cats with 
otitis media and includes a protocol for feline ear 
examination using low-field magnetic resonance.

Case description

Case 1. A three-and-a-half-year-old male Domestic 
Shorthair cat was presented to the Department of 
Surgery and Radiology at the University of Warmia 
and Mazury. The cat had a deformation of the right 
ear pinna and it showed neurological symptoms: 
head tilt, protrusion of the third eyelids, ataxia. The 
immune status was unknown. The general exami-
nation revealed chronic right otitis externa with 
large volume discharge and severe swelling and 
fibrosis of the auditory canal. It was not possible 
to investigate the tympanic membrane due to the 
difficulty in accessing it for otoscopic examination 
(swelling, purulent discharge). Serological tests 
for FeLV/FIV, toxoplasmosis were not performed. 
Complete blood count and serum biochemistry 
indicated non-significant changes. Radiographic 
imaging of the middle ear did not reveal any signifi-
cant abnormal features. Neurological abnormalities 
were a clear indication for magnetic resonance im-
aging to examine possible intracranial involvement.

Case 2. A nine-year-old male Domestic Shorthair 
cat had been treated for otitis externa of the left 
ear using ear drops with miconazolepolymyxin B 
sulphate, nitrate, prednisolone acetate (Surolan™, 
Janssen Pharmaceutica N.V., Belgium) for five weeks. 
An antibiogram was not performed. The cat had 
presented intermittent periods of remission, dur-
ing which no discharge was evident in the external 
auditory canal. The owner had occasionally observed 
neurological (head tilt) and behavioural (loss of 
food while eating, shaking its head, decreased ap-
petite) symptoms. On general examination, the cat 
appeared normal without neurological symptoms. 
Moreover, the cat demonstrated pain during ex-
amination of the oral cavity, especially when it was 
open. Otoscopic examination showed otitis externa 
with purulent discharge near the tympanic mem-
brane, and it could not be determined whether the 
membrane was intact. Serological tests for FeLV/ 
FIV were negative. Complete blood count and serum 
biochemistry were normal. Radiography of the mid-
dle ear revealed no significant pathological changes.

Magnetic resonance protocol. All images were 
obtained with a low-field magnetic resonance im-
aging device (Vet-MR Grande, Esaote, 0.25T, Italy). 
The investigation was performed with a coil for 
a small animal (a dual-phase array coil) in dorsal 
recumbency. During examination, the standard 
protocol was used, which included pre-contrast: 
T1-weighted spin echo (SE), T2-weighted fast 
spin echo (FSE) in transverse, sagittal and dor-
sal planes, fluid-attenuated inversion recovery 
(FLAIR) sequence in dorsal plane and post-contrast 
T1-weighted SE sequences in all planes. The pa-
rameters used for each of the sequences are given 
in Table 1. Post-contrast sequences were acquired 
after intravenous administration of gadolinium 
contrast agent at a dosage of 0.2 mmol/kg body 
weight (Omniscan, GE Healthcare, USA).

On the MRI the first cat showed abnormal con-
tent in the right middle ear in all sequences. In 
pre-contrast transverse, dorsal and sagittal T1-
weighted images, the lesion had an intensity com-
parable to brain tissue with subtle hyper-intensity 
in the middle of the dorsolateral compartment. 
The space occupied by this abnormal content was 
sharply demarcated by the bony borders of the mid-
dle ear. In post-contrast T1-weighted images, there 
was a non-uniform enhancement of the lesion, es-
pecially in the dorsolateral compartment and on 
the rim of the ventromedial compartment of the 
tympanic bulla with a hypo-intense centre. A cir-
cumference enhancement of the ventromedial part 
was most visible in transverse and sagittal planes. 
Moreover, transverse T1-weighted contrast-en-
hanced images had slightly increased signal inten-
sity in the membranous labyrinth (Figure 1). In the 
T2-weighted images, the lesion had a heterogene-
ously increased signal intensity to brain tissue, but 
was less intense than cerebrospinal fluid (CSF). In 
the FLAIR sequence, the pathological lesion was 
distinctly hyper-intense compared to other tissues 
with a narrow area of increased signal intensity 
in the middle of the ventromedial tympanic bulla 
compartment (Figure 2). These changes were con-
sistent with otitis media in the middle-ear space 
and were suggestive of otitis interna.

The pre- and post-contrast MRI protocol for the 
second case was the same as in the first cat, with an
recess and dorsolateral compartment. Septum in the tympanic cavity was poorly seen in pre-contrast and post-contrast T1 and GE weighted images, unlike in the T2 weighted image (Figure 2). The material in T2-weighted FSE sequences was markedly hyper-intense to brain tissue and CSF. The contrast additional gradient echo (GE) weighted sequence, but without a FLAIR sequence (Table 1).

In pre-contrast T1 and GE weighted images of the second cat, the lesion, high in water, was heterogeneously isointense to brain tissue with a poorly visible border, especially in the area of the epitympanic recess and dorsolateral compartment. Septum in the tympanic cavity was poorly seen in pre-contrast and post-contrast T1 and GE weighted images, unlike in the T2 weighted image (Figure 2). The material in T2-weighted FSE sequences was markedly hyper-intense to brain tissue and CSF. The contrast

Table 1. Summary of the parameters of sequences used in clinical studies

<table>
<thead>
<tr>
<th>Sequences</th>
<th>Plane</th>
<th>Plane</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>TI (ms)</th>
<th>NEX</th>
<th>Matrix</th>
<th>FOV (mm)</th>
<th>Flip angle</th>
<th>Slice thickness (ms)</th>
<th>Time</th>
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<td>90°</td>
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FLAIR = fluid-attenuated inversion recovery, FOV = field of view, FSE = fast spin echo, GE = gradient echo, NEX = number of excitations, SE = spin echo, TE = echo time, TI = inversion time, TR = repetition time.

Figure 1. Magnetic resonance imaging at the level of the tympanic bulla. The bony septum dividing the tympanic cavity is well-defined (black arrow head). (A) Pre-contrast transverse T1-weighted spin echo image (repetition time (TR) = 870 ms, echo time (TE) = 18 ms). There is a sharply-demarcated mass with intensity comparable to brain tissue and subtle hyper-intensity in the middle of the dorsolateral compartment. (B) Post-contrast transverse T1-weighted spin echo image (TR = 870 ms, TE = 18 ms). There is a non-uniform enhancement of mass in the dorsolateral compartment and a rim of increased signal intensity in the ventromedial compartment of the tympanic bulla (white arrow). Moreover, a contrast-enhancement is evident with a slightly increased signal intensity in the area of the membranous labyrinth (white arrow head)
enhancement on post-contrast T1-weighted SE sequences was similar to the cat in Case 1. These changes were assessed as a lesion with high water content occupying the middle ear space.

DISCUSSION AND CONCLUSIONS

There is a limited number of reports on the usefulness of MRI in the diagnosis of feline ear diseases (Allgoewer et al. 2000; Mellema et al. 2002; Garosi et al. 2003; Sturges et al. 2006). The otitis of the middle ear is usually problematic for diagnosis (Allgoewer et al. 2000). The peripheral vestibular symptoms are hidden as long as inflammation affects the internal ear (Remedios et al. 1991). Because of the absence of obvious changes, radiography is not helpful in the early diagnosis of middle ear diseases (Allgoewer et al. 2000). Computed tomography is more useful in identification of bony components, whereas MRI allows better identification of soft tissues, nerves, vessels and labyrinthine fluid (Garosi et al. 2003). This paper describes the MRI findings of otitis media in two cats. The conventional MRI protocol of the middle ear should include pre- and post-contrast T1 sequences in the dorsal and transverse planes, the T2 sequence in the dorsal and transverse planes and an additional FLAIR and short tau inversion recovery sequence in the dorsal or transverse planes. The dorsal and transverse planes enable observation of the two sides of the ear, but pathological changes most often affect only one side (Allgoewer et al. 2000). The middle-ear lesion in the first cat in the FLAIR sequence was clearly hyper-intense compared to other tissues with a narrow area of increased signal intensity in the middle of the ventromedial tympanic bulla compartment. The gradient echo sequence in the transverse plane (TR = 645 ms, TE = 20 ms) at the level of the tympanic bulla. There is a mass which is non-homogeneously isointense to brain tissue with a poorly visible border, especially in the area of the epitympanic recess and dorsolateral compartment. Bony septum in the tympanic cavity could not be visualised clearly.

Figure 2. Magnetic resonance of the middle ear. (A) Fluid-attenuated inversion recovery sequence in the dorsal plane (repetition time (TR) = 5060 ms, echo time (TE) = 100 ms, inversion time (TI) = 1350 ms). The mass was distinctly hyper-intense compared to other tissues with a narrow area of increased signal intensity in the middle of the ventromedial tympanic bulla compartment. (B) The gradient echo sequence in the transverse plane (TR = 645 ms, TE = 20 ms) at the level of the tympanic bulla. There is a mass which is non-homogeneously isointense to brain tissue with a poorly visible border, especially in the area of the epitympanic recess and dorsolateral compartment. Bony septum in the tympanic cavity could not be visualised clearly.
tients, especially in the dorsolateral compartment and on the rim of the ventromedial compartment of the tympanic bulla with a hypo-intense centre. A circumference enhancement of the ventromedial part was most visible in transverse and sagittal T1-weighted planes (Figure 1). The otitis media is usually characterised by gadolinium enhancement alongside the internal border of the tympanic bulla because of the inherence of vascularised tissues (Allgoewer et al. 2000). The healthy tympanic bulla gives an attenuation signal on all sequences. Free fluid in the middle ear is isointense to the brain on T1-weighted sequences and hyper-intense on T2-weighted sequences (Garosi et al. 2001).

The MRI modality allows the diagnosis of different disorders of the membranous labyrinth. In chronic inner ear inflammation, the fluid which appears in the internal ear suppresses the signal in T2-weighted sequences (Garosi et al. 2001). Labyrinthosis may increase gadolinium enhancement, as a result of inflammation or decrease the haemoperilymphatic obstacle (Vignaud et al. 1995). The first cat with chronic middle ear inflammation on transverse T1-weighted contrast-enhanced images had a slightly increased signal intensity in the membranous labyrinth (Figure 1).

The radiographic modality allows the diagnosis of chronic middle and internal ear disorders, but with low sensitivity (Garosi et al. 2003). CT is more sensitive for middle ear diseases but visualisation of the cerebellum and brainstem is limited by bone artefacts and the technique is not sufficiently sensitive to detect different soft tissue structures (Negrin et al. 2010). MRI allows the differentiation of chronic hematomas, empyemas and middle and internal ear neoplasia (Tsuchiya et al. 2003). Through the MRI modality, it is possible to distinguish between free fluid and solid material (Allgoewer et al. 2000). Final diagnosis of otitis media in cats should be based on an interview, clinical examination, radiography and on MRI analysis.

REFERENCES


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