Clinical presentation, treatment, and outcome of dacryocystitis in rabbits: a retrospective study of 28 cases (2003-2007)

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Objective: To document the clinical presentation, diagnostics, treatment, and clinical outcome of rabbits with dacryocystitis.

Materials and methods: This retrospective study included 28 rabbits diagnosed with dacryocystitis. Available records of clinical and ophthalmological examinations, bacteriological samplings, diagnostic imaging, and treatment were reviewed. A telephone survey of the owners was conducted to evaluate recovery and recurrences.

Results: The mean age of the 28 rabbits presenting with ocular discharge from the nasolacrimal duct was 4.4 years. In 25 rabbits (89%), dacryocystitis was a unilateral finding. No underlying cause could be determined in 10 animals (35%). Dental malocclusion was observed in 14 rabbits (50%) and rhinitis in two animals (7%), with one animal showing both symptoms (4%). One rabbit (4%) presented with panophthalmitis. Most animals (96%) received topical antibiotic treatment. If necessary, additional topical (acetylcysteine, vitamin A ointment, nonsteroidals) or systemic treatment (antibiotics, nonsteroidals, paramunity inducer, and glucocorticoids) was provided. The mean duration of therapy was 5.8 weeks. The nasolacrimal duct was flushed in 27 of 31 affected eyes (87%). Dentistry was performed in 80% of the animals suffering from malocclusion. Regarding the clinical outcome, 12 animals (43%) showed complete recovery, eight rabbits (28%) were euthanized, three (11%) died due to unrelated causes, and three (11%) were lost to follow-up. Two rabbits (7%) continue to display signs of dacryocystitis and are being treated symptomatically by the owners.

Conclusions: This study reports the clinical presentation, treatment, and outcome of dacryocystitis in rabbits and outlines the importance of examination of the oral cavity, diagnostic imaging, and bacteriologic sampling.
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Key Words: dacryocystitis, rabbit, nasolacrimal duct, malocclusion, bacterial infection, veterinary ophthalmology.
Introduction

Rabbits have for many years been widely used as laboratory animals by pharmaceutical companies and research institutes. In recent years however, they have become increasingly popular as pet animals and are therefore often encountered in veterinary small animal practices. Rabbits are presented to veterinarians mainly due to parasitic, dental or infectious diseases but also because of ophthalmic disorders. An investigative study on 586 New Zealand White rabbits living in commercial breeding facilities revealed an incidence rate of 9.6% for ophthalmic diseases.\(^1\) The predominant ophthalmic disease observed was blepharitis, followed by cataract and conjunctivitis. Dacryocystitis was found in only 0.2% of the examined animals. A clinical study on 344 rabbits at the Veterinary Medical Hospital, University of California, Davis showed a comparable incidence rate of 10% for ophthalmic diseases, with 73% of these animals showing clinical signs of dacryocystitis.\(^2\) Therefore, ocular discharge is a common reason for presenting rabbits to veterinary services and can relate not only to conjunctivitis but also to dacryocystitis and nasolacrimal duct infection.

Dacryocystitis is an inflammation of the lacrimal sac that is often accompanied by a nasolacrimal duct obstruction. A common cause for this disease in the rabbit is an underlying dental problem that blocks the nasolacrimal duct. Less frequently, a primary bacterial infection can be established as the eliciting factor. Diagnosis is made clinically during examination by the expression of purulent material from the nasolacrimal punctum with pressure on the skin beneath the medial canthus or by flushing of the nasolacrimal duct. In some cases, the lacrimal sac is even visually and palpably distended with pus. Secondary findings include conjunctivitis, corneal edema and keratitis due to the permanent purulent discharge on the cornea.\(^3, 4\)

So far, several studies have been published, concerning the microbiology and specific anatomy of the nasolacrimal duct of rabbits with dacryocystitis.\(^1, 2, 4-13\) However, to the best of our knowledge, information on the clinical outcome of treated patients affected by this disease is scarce. In this
A retrospective study, 28 rabbits diagnosed with dacryocystitis were followed regarding the clinical signs, diagnostics, treatment and clinical outcome.

**Materials and Methods**

Dacryocystitis was diagnosed in twenty-eight rabbits referred to the Veterinary Teaching Hospital of the Vetsuisse Faculty, University of Zurich, with ocular discharge between March 2003 and May 2007. All rabbits fulfilled the following inclusion criteria: (1) display of purulent discharge from the nasolacrimal duct and (2) no history of previous dacryocystitis. Data collected included the findings of clinical and ophthalmic examination, bacteriological sampling (if available), diagnostic imaging (if available), the treatment, and clinical outcome. A telephone survey of the owners was conducted in order to determine each animal’s progress beyond the final clinical examination at our clinic.

**Statistical analysis**

Data editing and all the statistical analysis was performed using Stata Software (StataCorp., 2009; Stata Statistical Software: Release 10.1; College Station, TX, USA:StataCorp LP). Analyses were carried out using the tab2 and the oneway command in STATA version 10 (StataCorp, 2007) for categorical analysis and analysis of variance. A p-value of $\leq 0.05$ was considered significant.

**Results**

From the database, twenty-eight rabbits with dacryocystitis were identified and observed. Sixteen of the presented animals were crossbred pet rabbits. Other breeds represented were eight dwarf and four lop eared rabbits. The animal population consisted of twenty males, seven females and one rabbit of unknown gender. The mean age was 4.4 years, ranging from 0.5 to 11 years. Twenty-three (82%) of the animals were presented due to ocular discharge (Fig. 1). In the remaining five (18%) animals, dacryocystitis was a secondary finding diagnosed during clinical examination. Three rabbits were presented for unrelated reasons not pertinent to the presence of dacryocystitis, one rabbit showed a
head tilt and respiratory disease and one animal was referred to the teaching hospital with panophthalmitis. The clinical features, duration of treatment, cause, recovery, recurrence and clinical outcome are summarized in Table 1.

Clinical examination

Clinical ophthalmic and oral examination was performed on all rabbits. Purulent discharge from the nasolacrimal duct was observed in all patients and primarily occurred unilaterally (25/28, 89%). Other associated pathologic findings were conjunctivitis (15/28, 53%), nasal discharge (8/28, 28%) (Fig. 2), keratitis (6/28, 21%), periorbital swelling (5/28, 18%) and panophthalmitis (1/28, 4%). In many animals, examination of the oral cavity revealed dental disorders with malocclusion (15/28, 53%).

Diagnostic imaging

Due to the financial limitations of the owners, diagnostic imaging of the head was carried out in only eight of the fifteen rabbits displaying dental disorders. Diagnostic imaging consisted of mere radiographs. Unfortunately, dacryocystorhinography could not be conducted in any of the animals. Radiological changes were seen in four rabbits and consisted of alveolar periosteitis, tooth root infection, periosteal new bone formation and osteolysis of the maxillary bone (Fig. 3).

Bacteriological sampling

Swab specimens of the purulent discharge were taken in eight rabbits at the clinical examination or during nasolacrimal flushing. Placed in a commercially available transport device, they were sent to the bacteriological laboratory of the Vetsuisse Faculty, University of Zurich, for further culturing. In four rabbits, one pathogen (E.coli, Staphylococcus intermedius, Staphylococcus sp. and Gramnegative Cocci without further specification, respectively) was found in the nasolacrimal discharge. In two rabbits, E.coli was found together with Staphylococcus sp. or Streptococcus sp., respectively. No bacterial growth was detected in two samples.

Treatment
The mean duration of therapy was 5.8 weeks, ranging from 1 day to 64 weeks. The duration of treatment had a significant influence regarding the clinical outcome (p = 0.0008). The mean treatment time in the rabbits with healing was 2.9 weeks compared to a mean treatment time of 8.3 weeks in the animals with no recovery.

Most (27/28, 96%) rabbits were initially treated with topical antibiotic therapy: aminoglycosides combined with non-steroidal anti-inflammatory agents (14/27), fluoroquinolones (9/27), chloramphenicol (2/27) and triple antibiotic combinations (aminoglycoside/Polymyxin B/bacitracin) (2/27). Depending on the severity of the clinical signs, acetylcysteine (4/27), vitamin A ointment (4/27) or non-steroidal agents (3/27) were topically applied.

Many animals required systemic treatment (13/28, 54%). Antibiotics were administered in ten rabbits, alone (4/10) or in combination with non-steroidal anti-inflammatory drugs (5/10) and glucocorticoids (1/10), respectively. Antibiotics used for systemic therapy were as follows: fluoroquinolones (6/10), chloramphenicol (2/10), aminoglycosides (1/10) and macrolides (1/10). In two rabbits, the systemic treatment exclusively consisted of non-steroidal inflammatory drugs. In one very mildly affected rabbit displaying rhinitis, the sole treatment for the dacryocystitis was flushing of the nasolacrimal duct with physiological saline. Additionally, a paramunity inducer (chemically inactivated parapoxvirus) was systemically administered for the treatment of the rhinitis.

Systemic treatment had a significantly negative association on the recovery (p = 0.022) and the outcome (p= 0.029) of these rabbits with dacryocystitis.

Nasolacrimal flushing with 0.9% sodium chloride was conducted in twenty-seven (87%) of the thirty-one affected eyes. If necessary, inhalation anesthesia with isoflurane was administered for timorous rabbits not used to handling. Twelve ducts were patent and fourteen obstructed, with one flushing not being specified. Successive flushing with medical agents was carried out in seven eyes. The main agent used for flushing was a fluoroquinolone antibiotic alone (4/7) or accompanied by acetylcysteine (1/7). One duct was flushed with a combination of an aminoglycoside antibiotic and a non-steroidal drug.
accompanied by acetylcysteine and one flushing was accomplished with acetylcysteine alone. Flushing and patency of the duct had no significant influence on recovery or the outcome in this study group (p > 0.05 in all cases).

Dentistry with incisor and/or molar trimming was performed in most (12/15) of the rabbits suffering from malocclusion.

Three rabbits (11%) were euthanized at the first clinical examination due to the severity of the underlying disease causing the dacryocystitis.

Follow-up examinations

Thirteen (52%) of the twenty-five remaining animals returned to the Veterinary Medical Teaching Hospital of the Vetsuisse Faculty, University of Zurich, for follow-up examinations. Most rabbits (5/13) were seen for one check-up only. In some cases, two (2/13), three (4/13), or four or more (2/13) follow-up examinations were necessary. Additional radiography and bacteriological sampling were conducted in one and four rabbits, respectively. At the second check-up, one rabbit was euthanized due to medical non-response and worsening of the symptoms, and one rabbit with an additional phlegmone died while being hospitalized at the Vetsuisse Faculty, University of Zurich. In two rabbits, the treatment remained unchanged during the treatment period. Many modifications were made to the treatment due to a poor response to therapy in the other nine animals. Number of rabbits with changes in therapy was as follows: systemic and topical modifications in 5 rabbits, systemic modifications in 2 rabbits and topical modification in 1 rabbit, respectively.

Topical antibiotic treatment was changed in six rabbits due to personal preference, with two of them additionally receiving non-steroidal and steroidal topical therapy, respectively. In three of these six animals, this was done even though the detected microorganisms were sensitive to the formerly used antibiotics in repeated microbial testing.

In seven animals, systemic treatment was initiated or changed. Additional therapy included antibiotics in one rabbit and antibiotics accompanied by a non-steroidal anti-inflammatory agent in two animals.
In the other four rabbits, the systemic antibiotics were changed with a supplemental administration of a non-steroidal anti-inflammatory agent in two of them.

Of these nine rabbits requiring changes in therapy, one patient suffering from the secondary formation of a corneal abscess and uveitis was enucleated and one rabbit was euthanized due to medical non-response and worsening of the symptoms at a later check up.

Modifications to the therapy (topical and systemic) had no significant influence regarding recovery or the outcome. Due to the many alterations in treatment, statistics regarding the specific agents could not be established.

*Telephone survey*

Of the twenty-eight rabbits, five (18%) animals were euthanized at the Vetsuisse Faculty, University of Zurich, one (4%) animal died as an in-patient and three (11%) animals were lost to follow-up. The owners of the remaining nineteen (68%) animals were surveyed about the progress of the disease to assist in determining long-term outcome. Nine animals have subsequently been checked by the referring veterinarians, with three of them later being euthanized due to clinical non-response to the therapy.

*Clinical outcome*

Of the twenty-eight rabbits treated for dacryocystitis at the Vetsuisse Faculty, University of Zurich, twelve (43%) animals showed complete recovery after an average treatment time of 2.9 weeks. Two of these animals showed recurrences after several months that resolved with additional treatment. Of the remaining sixteen rabbits, eight (28%) were euthanized after an average treatment time of 3.1 weeks, three (11%) died due to unrelated causes during the treatment period and three (11%) were lost to follow-up. Two (7%) animals continue to display discharge and are presently being treated by the owners.

Findings regarding the cause of dacryocystitis and the corresponding clinical outcome are summarized in Table 2. The most important reason for the development of this disease identified in our study was
dental disorders with fourteen (50%) affected animals with no other signs and one rabbit (4%) were dental disorders as well as signs of rhinitis were observed. No cause could be found in 10 (35%) rabbits, while 2 (7%) animals showed signs of rhinitis and one (4%) animal suffered from panophthalmitis.

In the statistical analysis comparing age, topical and systemic therapy, lavage and patency of the nasolacrimal duct, the cause, recovery, recurrence and outcome, only the administration of systemic treatment and the duration of therapy and had a significant effect. Both parameters had a negative association on the outcome and the systemic treatment additionally on the recovery.

**Discussion**

The two main causes known to induce dacryocystitis in rabbits are dental disorders and rhinitis. As also seen in this study with 53% affected animals, most cases of dacryocystitis are secondary to an underlying dental disease accompanied by a blockage of the nasolacrimal duct and resultant secondary bacterial infection. This blockage is based on a predisposition of the rabbit due to specific anatomical properties that differ from other animals such as dogs, cats, horses, and ungulates.\(^{(2, 3, 5, 6, 10, 11, 13)}\)

The rabbit displays only one single nasolacrimal punctum, which is located in the anteromedial aspect of the lower eyelid. The duct is very slender and consists of a tortuous route with two sudden constrictions. One is a proximal bend when the duct enters the maxillary bone, and the other narrowing is located more distally at the base of the incisor tooth roots. Additionally, the duct passes very close to the roots of premolar and incisor teeth, has a rich vascular and lymphatic supply, undulations of the epithelium and a small opening into the nasal vestibule.

The second well known cause for dacryocystitis is a primary bacterial infection.\(^{(6, 8-11)}\) *Pasteurella sp.* is the best studied bacterial pathogen in rabbit nasolacrimal ducts, but *Staphylococcus aureus* is also often encountered in diseased rabbits with conjunctivitis or dacryocystitis. Other bacteria such as *Staphylococcus sp.*, *Moraxella sp.*, *Oligella urethralis*, *Pseudomonas*, and *Streptococcus viridans* have
been detected in the nasolacrimal ducts of rabbits with epiphora but also in healthy control animals. They are therefore considered to be part of the resident flora of the nasolacrimal duct. It is very unfortunate that not all patients in this study were sampled for bacteriological involvement, especially the animals suffering from rhinitis. Therefore, data on bacterial involvement and sensitivity to the antibiotics used for treatment was very scarce. We recommend routine bacteriological sampling in all patients with dacryocystitis to adjust the antibiotic treatment.

A temporarily or permanent reduced immune status could also promote the development of a primary bacterial infection, since many potentially pathogenic bacteria are commensals in the nasolacrimal duct of healthy rabbits, as described earlier. In 35% of the rabbits in our study, no underlying cause could be established. This group of rabbits mainly consisted of healthy animals (7/10) but also included three rabbits suffering from unrelated severe diseases. A reduced immune status could have been a possible eliciting factor, although no blood work or further investigations were conducted to confirm this hypothesis. This could lead to a consequential bacterial infection in those rabbits that were in apparently good health.

In this study, no significant differences regarding recovery and the outcome could be established when comparing the different causes of dacryocystitis. Further prospective studies are needed to evaluate this disease, especially in rabbits without obvious signs of a primary disease such as dental problems or rhinitis.

As seen in this retrospective study, financial restraints often preclude further diagnostics and/or intensive treatment of pet rabbits in Switzerland. In all twenty-eight cases, merely twelve bacteriologic samples and nine radiographs were taken throughout the treatment period and no dacryocystorhinography could be conducted. Therefore, determination of etiology and prognosis was challenging.

The significant negative influence of systemic treatment regarding the recovery and the outcome indicates that the prognosis of severely affected animals requiring systemic therapy is guarded. It was
also statistically demonstrated, that the more prolonged the treatment period, the poorer the outcome in this disease. The mean treatment time in the rabbits that healed was 2.9 weeks, compared to a mean treatment time of 8.3 weeks in the animals with no recovery. This shows a strong tendency towards a poor prognosis if any complications in the treatment are experienced.

An interesting finding in this study was that the patency of the nasolacrimal duct was not a significant indicator for a positive outcome in this disease. In 57% of patients with no recovery, the duct remained blocked. This was also seen, however, in 36% of the rabbits with complete recovery.

In this study, four of the twelve animals with complete recovery showed epiphora as a minor complication. This could be explained by scarring and fibrosis of the delicate duct during the presence of inflammation, even though in three of these rabbits the nasolacrimal ducts were flushed during treatment and were patent.

Recurrence of the purulent discharge originating in the nasolacrimal duct was seen in three animals. The eliciting cause for dacryocystitis in two of these animals was dental disorders alone and dental disorders accompanied by rhinitis, respectively. Since dental disorders are usually a chronic problem, the relapses were not surprising in these cases. No cause could be found in the third rabbit, which was otherwise healthy with a good occlusion of the teeth. It suffered from several relapses between 2003 and 2007. When the owner was questioned about the progress of the disease at the end of 2007, the rabbit had been healthy without any signs of dacryocystitis for several months and was therefore considered healed.

To find out more about etiology, prognosis and most importantly about a more successful therapy, further prospective studies are needed. This would be especially helpful, since in the animals of the present study, the therapy was often changed on personal experience. This could also be explained due to the little literature that exists about dacryocystitis in rabbits. The authors also think that the complexity of this disease is often underestimated in rabbits.
In conclusion, the most common treatment for dacryocystitis included the empirical use of topical antibacterial drugs and flushing of the nasolacrimal duct. Unfortunately, many veterinarians underestimate the often poor response to topical treatment with antibiotics and the resultant chronic problem that can develop, due to underlying severe diseases. Considering the specific anatomical condition of the oculodental region in rabbits, it is important to examine the oral cavity thoroughly and to use diagnostic imaging and bacteriological sampling in evaluating the etiology, treatment and prognosis.
References


**Figure 1.** Ocular discharge emerging from the nasolacrimal duct of a rabbit with dacryocystitis.

**Figure 2.** Nasal discharge in a rabbit with dacryocystitis.

**Figure 3.** (a, b) Radiographs of the skull of a rabbit displaying dacryocystitis due to a dental disease. Severe soft tissue swelling with osseous involvement (arrow) and alveolar periostitis of the first and second cheek teeth (arrow head) is seen. In the lateral picture, an uneven occlusal plane is additionally visible (*).
Table 1. Clinical features, diagnostics, duration of treatment, cause, recovery, recurrence and outcome of rabbits with dacryocystitis

<table>
<thead>
<tr>
<th>Case #</th>
<th>Age (years)</th>
<th>Eye affected</th>
<th>Lavage of nasolacrimal duct</th>
<th>Patency of nasolacrimal duct*</th>
<th>Bacteriological samples (noted if done)</th>
<th>Diagnostic imaging (noted if done)</th>
<th>Total duration of treatment (weeks)</th>
<th>Cause of disease</th>
<th>Recovery</th>
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<td>Healed (after enucleation)</td>
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<td>Yes</td>
<td></td>
<td></td>
<td>1</td>
<td>Dental disorders</td>
<td>No</td>
<td>Euthanasia</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>4</td>
<td>OS</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>5</td>
<td>Unknown</td>
<td>No</td>
<td>Euthanasia</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>3</td>
<td>OS/OD</td>
<td>Yes</td>
<td>No -&gt; Yes</td>
<td>Yes</td>
<td></td>
<td>6</td>
<td>Unknown</td>
<td>No</td>
<td>Died during treatment period**</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>6</td>
<td>OS</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>Rhinitis</td>
<td>No</td>
<td>Died during treatment period**</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>4</td>
<td>OS</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
<td>0.5</td>
<td>Dental disorders</td>
<td>No</td>
<td>Died during treatment period**</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>3</td>
<td>OS</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>14</td>
<td>Dental disorders</td>
<td>ltf</td>
<td>Lost to follow-up</td>
<td></td>
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<td>27</td>
<td>11</td>
<td>OS</td>
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<td>No</td>
<td></td>
<td></td>
<td>not stated</td>
<td>Unknown</td>
<td>ltf</td>
<td>Lost to follow-up</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>6</td>
<td>OD</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
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<td>not stated</td>
<td>Unknown</td>
<td>ltf</td>
<td>Lost to follow-up</td>
<td></td>
</tr>
</tbody>
</table>

* -> showing the progress during treatment,  ** -> died due to an unrelated cause
Table 2. Clinical outcome regarding the cause of dacryocystitis

<table>
<thead>
<tr>
<th>Cause of disease (number of affected animals)</th>
<th>Recovery</th>
<th>No recovery</th>
<th>Death due to unrelated cause</th>
<th>Lost to follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental disorders (n=14)</td>
<td>6 [43%]</td>
<td>6 [43%]</td>
<td>1 [7%]</td>
<td>1 [7%]</td>
</tr>
<tr>
<td>Dental disorders and rhinitis (n=1)</td>
<td>1 [100%]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhinitis (n=2)</td>
<td>1 [50%]</td>
<td></td>
<td>1 [50%]</td>
<td></td>
</tr>
<tr>
<td>Panophthalmitis (n=1)</td>
<td>1 [100%]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown cause (n=10)</td>
<td>5 [50%]</td>
<td>2 [20%]</td>
<td>1 [10%]</td>
<td>2 [20%]</td>
</tr>
<tr>
<td>Total number of rabbits (n=28)</td>
<td>12 [43%]</td>
<td>10 [35%]</td>
<td>3 [11%]</td>
<td>3 [11%]</td>
</tr>
</tbody>
</table>

Figure 1.
Figure 2.

Figure 3a.
Figure 3b.