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ORIGINAL RESEARCH

Retrospective study identifying risk factors for dacryocystitis in pet rabbits

Joanna Hedley¹ | Victoria Ede¹ | Charlotte Dawson²¹ Beaumont Sainsbury Animal Hospital, Royal Veterinary College, London, UK² Royal Veterinary College, Hatfield, UK**Correspondence**

Joanna Hedley, Beaumont Sainsbury Animal Hospital, Royal Veterinary College, Royal College Street, London NW1 0TU, UK.
Email: jhedley@rvc.ac.uk

Present address

Victoria Ede, Plymouth Veterinary Group, Plymouth, UK

Abstract

Background: Dacryocystitis has been suggested to be a relatively common condition in pet rabbits and is often associated with concurrent disease. The aim of this study was to investigate potential risk factors associated with dacryocystitis in a pet rabbit population.

Methods: A retrospective review of medical records from all rabbit cases evaluated at a single first opinion/referral UK exotics clinic between 2015 and 2018 was performed.

Results: Dacryocystitis was identified in 55 of 821 rabbits (6.70%) examined over the study period. Of those rabbits with dacryocystitis, dental disease was found in 24 rabbits (45%), respiratory disease in 20 rabbits (38%), aural disease in seven rabbits (13%) and concurrent ocular disorders in 15 rabbits (23%). Breed status was found to be a significant risk factor, with Lionhead/Lionhead cross and Dwarf Lop/Dwarf Lop cross rabbits being more likely to have dacryocystitis.

Conclusion: These results suggest that a breed predisposition for dacryocystitis may exist, particularly for the popular Lionhead and Dwarf Lop rabbits, and veterinarians should advise clients on this accordingly.

INTRODUCTION

Dacryocystitis has been suggested to be a common condition in pet rabbits,¹ but there are relatively few studies reporting the prevalence of ocular disease and particularly dacryocystitis in the pet rabbit population. In a survey of UK rabbit owners, 12.9% of 1254 rabbits were reported as having 'eye problems'.² A retrospective review of clinical records from 6349 rabbits attending veterinary practices in England recorded a slightly lower prevalence of 7.3% of rabbits having ocular disease.³ Neither study, however, looked specifically at dacryocystitis. A retrospective study in the USA looking at patients in one veterinary clinic found that 10% of 344 rabbits presented with ocular disease, of which 73% showed clinical signs of dacryocystitis.⁴ In contrast, in a laboratory population, a study of 586 New Zealand White rabbits found that 9.6% had ophthalmic disease, although only 0.2% were diagnosed with dacryocystitis.⁵

Rabbits have been suggested to be susceptible to dacryocystitis due to the unique anatomy of their nasolacrimal duct, which can easily become obstructed.⁶ The duct starts at a single slit-like opening (punctum) located in the conjunctiva of the lower

lid close to the medial canthus, following a tortuous path to empty into the nares.^{7,8} After the lacrimal sac and canal, the lacrimal duct reduces from 2 to 1 mm in diameter and curves where it passes close to the maxillary incisor root, and it is here that blockage usually occurs.^{4,9} Acute dacryocystitis can occur due to conjunctivitis causing temporary obstruction of the lacrimal sac, impaired drainage and secondary bacterial infection.¹⁰ More typically, chronic dacryocystitis is suggested to develop secondary to dental disease with elongation of tooth apices and periducal osteomyelitis.⁹ Alternatively, infection may ascend from the nasal cavity, as seen in animals with ongoing rhinitis.⁶ Dacryocystitis should not be confused with epiphora, where tear drainage is impeded and overflow occurs without inflammation or infection of the duct. Epiphora may occur as a consequence of excessive tear production or reduced drainage if the nasolacrimal duct is narrowed or blocked. While normal lacrimal gland secretions can have a milky colouration, dacryocystitis is characterised by a mucopurulent discharge.⁹

The clinical aspects of dacryocystitis have been described in a case series of 28 rabbits in one clinic in Switzerland.¹¹ Those rabbits were predominantly male

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(20/28) and had a mean age of 4.4 years at first presentation. Dental disease and rhinitis were identified as concurrent diseases in 50% and 7% of animals, respectively. That study did not establish, however, whether sex, age, breed or concurrent disease are risk factors for developing dacryocystitis.

Brachycephalic rabbit breeds have been suggested to be at higher risk of developing nasolacrimal duct disease.¹² In cats, a study using computed tomography (CT) dacryocystography assessed the effects of brachycephalic skulls on nasolacrimal drainage. That study showed that the higher the degree of brachycephaly, the steeper the orientation of the nasolacrimal duct and thus the more likely that drainage is affected.¹³ It is therefore possible that, as in cats, a shortened skull leading to a distorted nasolacrimal duct also applies to brachycephalic rabbits. Breeds such as the Netherland Dwarf, Lionhead and some Lop breeds are often seen to exhibit marked brachycephalism,¹⁴ although thus far, in rabbits, there is no defined system for the classification of brachycephaly to quantify this theory.

The aim of the current study was to investigate potential risk factors associated with dacryocystitis in a pet rabbit population.

MATERIALS AND METHODS

Medical records of all rabbits evaluated between 12 February 2015 and 12 February 2018 at a single first opinion/referral UK exotics clinic were reviewed retrospectively. Data collected included most recent weight, sex, neuter status, breed and presence of lop ears (based on breed). A subset of rabbit cases were then identified for further analysis based on the presence of the keywords or phrases 'dacryo', 'dacro', 'nasolacrimal', 'tear duct flush', 'isathal', 'exocin', 'tiacil', 'maxitrol' and 'chloramphenicol' in their records. These topical treatments were chosen because they were the topical medications kept routinely in the hospital during this time period. Additional data recorded from these cases included age at onset of clinical signs and the presence of concurrent dental, ear, ocular disease or respiratory disease based on any record of these disease processes in the available clinical notes. Cases were categorised as having respiratory disease if there was any mention of respiratory signs, including nasal discharge but also respiratory noise or dyspnoea. Cases were categorised as having dacryocystitis present if this was specified in their clinical records or if there was a description of clinical signs such as 'mucopurulent discharge of tear ducts' (Figure 1).

When categorising breeds from clinical records, breeds that were recorded as a breed crossed with 'X' were grouped with others of that breed. For example, rabbits listed as 'Lionhead X' were grouped with rabbits listed as 'Lionhead' to create the group 'Lionhead/Lionhead X'. Rabbits listed as 'crossbreed', 'unknown' or 'other' were grouped together to create the group 'crossbreed/unknown'.

Statistical analysis was performed using a commercially available software program (SPSS Statistics,



FIGURE 1 Purulent ocular discharge seen on clinical examination of a rabbit with dacryocystitis

version 26), and a p -value of <0.05 was taken to indicate statistical significance. Data for age were assessed for normality using the Shapiro–Wilk test. A χ^2 test or Fisher's exact test was calculated to evaluate any association between sex, neuter status, breed category and presence of dacryocystitis. Odds ratios and their 95% confidence intervals were calculated. Univariable and multivariable binary logistic regressions were implemented to evaluate the potential risk factors associated with dacryocystitis. Risk factors with $p < 0.1$ in the univariable binary logistic regression analysis were included in a multivariable model, and the manual backwards elimination method was used to derive the final model. Incomplete records were included in the data analysis, which accounted for the differences in the numbers of rabbits analysed for each risk factor.

RESULTS

A total of 821 rabbits were presented to the exotics clinic between 2015 and 2018, consisting of 305 male neutered, 140 male entire, 242 female neutered, 124 female entire rabbits and 10 of unknown sex. A total of 53 different breeds or breed crosses were recorded. Mini Lop/Mini Lop cross was the most common breed category (16.93%; $n = 139$), followed by Lop/Lop cross (13.89%; $n = 114$) (Table 1).

Using the search criteria keywords, records from a subset of 82 rabbits were reviewed in more detail. Of these, 55 rabbits met the inclusion criteria for the presence of dacryocystitis (6.70% of the total study population). These comprised 29 male neutered, four male

TABLE 1 Univariate logistic regression analyses of the association of risk factors and the presence of dacryocystitis

	Total	With dacryocystitis	Percent	χ^2 and <i>p</i> -values	Odds ratio (95% confidence interval)
Number of rabbits	821	55	6.70		
Sex				$\chi^2_1 = 0.63$, $p = 0.43$	
Male	445	33	7.42	$p = 0.43$	1.25 (0.72–2.19)
Female	366	22	6.01	Ref	
Neuter status				$\chi^2_3 = 8.50$, $p = 0.037$	
Male entire	140	4	2.86	Ref	
Male neutered	305	29	9.51	$p = 0.019$	3.57 (1.23–10.37)
Female entire	124	5	4.03	$p = 0.60$	1.43 (0.38–5.44)
Female neutered	242	17	7.02	$p = 0.10$	2.57 (0.85–7.79)
Breed				$\chi^2_{15} = 26.45$, $p = 0.034$	
Lionhead/Lionhead cross	94	12	12.77	$p = 0.01$	4.57 (1.43–14.67)
Mini Lop/Mini Lop cross	139	12	8.63	$p = 0.07$	2.95 (0.93–9.40)
Lop/Lop cross	114	8	7.02	$p = 0.07$	2.36 (0.69–8.05)
Dwarf Lop/Dwarf Lop cross	50	6	12.00	$p = 0.03$	4.26 (1.15–15.81)
Crossbreed/unknown	129	4	3.10	Ref	
Dutch/Dutch cross	46	2	4.34	$p = 0.69$	1.42 (0.25–8.03)
Dwarf	31	2	6.45	$p = 0.39$	2.16 (0.38–12.34)
Netherland Dwarf/Netherland Dwarf cross	72	2	2.78	$p = 0.90$	0.89 (0.16–5.00)
Angora/Angora cross	7	1	14.29	$p = 0.17$	5.21 (0.50–54.04)
British Giant/British Giant cross	4	1	25.00	$p = 0.06$	10.42 (0.88–123.45)
Chinchilla/Chinchilla cross	4	1	25.00	$p = 0.06$	10.42 (0.88–123.45)
English Spot/English Spot cross	9	1	11.11	$p = 0.25$	3.916 (0.39–39.16)
Harlequin	4	1	25.00	$p = 0.06$	10.42 (0.88–123.45)
Rex/Rex cross	38	1	2.63	$p = 0.88$	0.85 (0.09–7.79)
French Lop/French Lop cross	16	1	6.25	$p = 0.52$	2.08 (0.22–19.88)
Other breeds	67	0	0		

entire, 17 female neutered and five female entire rabbits. Data for age at first presentation were normally distributed, and cases were recorded from 3 months to 11 years of age (mean 58 ± 33 months). Fifteen breed categories presented with dacryocystitis. Breeds that were seen during the study period but did not present with dacryocystitis included the English Lop, Holland Lop, Cashmere Lop, Californian, Continental Giant, German Giant, New Zealand White, Beveren cross, Belgian Hare, Dwarf Hotot, Thrianta, Himalayan, American Sable cross, Norwegian Dwarf and Silver Marten (combined in Table 1 as 'other breeds').

Of those rabbits with dacryocystitis, dental disease was found in 25 rabbits (45%), respiratory disease in 21 rabbits (38%), aural disease in seven rabbits (13%) and concurrent ocular disorders in 15 rabbits (23%). Ocular disorders consisted of conjunctivitis ($n = 8$), corneal

ulcers ($n = 4$), Horner's syndrome ($n = 2$), exophthalmos ($n = 1$) and cataracts ($n = 2$), with two rabbits having multiple ocular disorders. Six rabbits had both dental and respiratory disease (11%). Only 10 (18%) rabbits had no concurrent dental, respiratory, ear or ocular disease.

A statistically significant association between sex and the presence of dacryocystitis was not found ($p = 0.43$). There was, however, an association between neuter status and the presence of dacryocystitis ($p = 0.037$), with the odds ratio (OR) of dacryocystitis being 3.57 (95 per cent confidence interval [CI] 1.23–10.37) higher for male neutered rabbits than male entire rabbits ($p = 0.019$). A statistically significant association was also found between breed and the presence of dacryocystitis ($p = 0.03$). The ORs of a Lionhead/Lionhead cross rabbit or a Dwarf

Lop/Dwarf Lop cross rabbit having dacryocystitis compared to a crossbreed rabbit were 4.57 (95 per cent CI 1.43–14.67) times and 4.26 (95 per cent CI 1.15–15.81) times higher, respectively ($p = 0.01$ and 0.03).

Carrying out a multivariable model with all the variables in Table 1 where $p < 0.1$ (neuter status, breed category) resulted in breed being the only independent predictor in the final model.

DISCUSSION

The prevalence results of this study appear to be similar to those found in a North American study. In this study, we identified dacryocystitis in 6.7% of rabbits, and in North America, it was reported as 7.3%.⁴ It is difficult to draw firm conclusions, however, as both of these studies were of single hospital populations and may not be representative of the rabbit population in the respective countries.

Of those rabbits that had dacryocystitis, it was found that 45% of rabbits had concurrent dental disease and 38% had respiratory disease. It is interesting that this appears to be similar to the 2009 study of 28 rabbits with dacryocystitis in Zurich. That study found that 53% had dental disease and 28% had nasal discharge.¹¹ In this study, rabbits were categorised as having respiratory disease if there was any mention of respiratory signs in the clinical notes, including nasal discharge, respiratory noise or dyspnoea. The wider definition would likely account for the higher number of rabbits recorded with respiratory signs and could potentially have miscategorised rabbits showing these signs due to a non-respiratory cause. It was also found that there was an overlap between dental disease and respiratory disease in this study, as six rabbits had both present, but from the clinical notes, it was impossible to establish which disease was the primary problem in these cases.

Interestingly, 19% of rabbits in this study did not have any concurrent diseases reported, perhaps suggesting that other factors, such as genetic or brachycephalic conformational abnormalities, could play a role. Due to the retrospective nature of this study and relying on clinical records alone, it is possible that some of these rabbits had a concurrent disease that was not detected at the time or was not recorded. Therefore, the prevalence of concurrent disease may have been higher, and ideally diagnostic imaging such as CT would have been performed to identify any concurrent disease at the time of presentation.

This study found that rabbits with dacryocystitis presented to the hospital at a mean age of 4 years 7 months with a range of 3 months to 11 years. This is very similar to the study of 28 rabbits in Zurich, which found a mean age of 4.4 years and a range of 6 months to 11 years.¹¹ Additionally, the fact that five rabbits less than a year old had presented with dacryocystitis suggests that there may be a genetic or conformational component to the disease process.

Further studies would be beneficial to investigate this relationship further.

Neuter status was found to be statistically significantly associated with dacryocystitis, with male neutered rabbits being particularly overrepresented. It is possible that owners who are conscientious and more likely to bring their rabbit to the veterinarian for routine neutering may also be more diligent at presenting their pets when displaying signs of disease, although further research would be needed to establish if this is a factor.

The most common breeds with dacryocystitis in this study were Lionheads, Mini Lops, Lops and Dwarf Lops. This is interesting because all of these breeds are brachycephalic.¹⁴ Comparatively, the Zurich study reported that 57% of rabbits were crossbreeds, and none were described as Lionheads.¹¹ This difference could be explained by a different breed popularity in Switzerland. This could also be because it was a small study or, most likely, in the authors' opinion, due to the issues of accurate breed recording on clinical records. Nonetheless, this study found breed to be statistically significant, suggesting its role as a risk factor for dacryocystitis. In particular, Lionhead and Dwarf Lop rabbits were significantly overrepresented.

Studies indicate that Lionhead rabbits are one of the most commonly kept breeds in the UK,^{2,15} and in this study, they made up 12.3% of the total hospital population. Although there are no data to show that this figure has increased from previous years, Lionhead was only recognised by the British Rabbit Council in 2002, making it a relatively new breed and suggesting a recent increase in popularity.¹⁶ In dogs, appearance has been shown to be the main reason why people purchase brachycephalic breeds, likely due to their 'cute neotenus looks'.¹⁷ A study looking at people's preference for rabbit faces also showed that those with brachycephalic faces were preferred.¹²

Unfortunately, there is a lack of a grading system for brachycephaly in rabbits, although considerable diversity in skull shape has been reported.¹⁸ Consequently, it is difficult to assess its relationship with dacryocystitis in a retrospective study such as this. It would therefore be beneficial to replicate the study that assessed nasolacrimal drainage problems in brachycephalic cats using CT dacrocystography¹³ in rabbits. This would ultimately confirm how rabbit skull shape affects the nasolacrimal duct and how this differs in different breeds. Ideally, a scale of brachycephalic confirmation severity that can be used in first opinion practice would be created in order to assess rabbits at the time of clinical examination. This would aid awareness for veterinarians and clients and could influence selection for future breed conformation.

The limitations of this study include its retrospective nature and relatively small sample size. Data were sourced from one veterinary clinic and thus may not provide a representative sample of the entire UK population. Additionally, the assumption made in this study was that the inclusion criteria identified all cases of dacryocystitis. There was, however, the possibility

that the disease was not recorded, for example, if it was mild or an incidental finding. Furthermore, how correctly the breed has been recorded on the clinical record depends on several factors. These include whether the veterinarian has accurately identified the breed, whether the owner is aware of the breed, whether the rabbit was sold or adopted to the owner as the correct breed and how pure the actual breed lineage is. Additionally, breed mixes were included in breed categories. This was because the rabbit had some key defining features of that breed and recording it as 'unknown' or 'crossbreed' would be inaccurate in the authors' opinion.

In conclusion, the findings of this study revealed that dacryocystitis is a relatively common disease in this study population (6.7%). Risk factors for dacryocystitis include sex/neuter status (male neutered) and breed (Lionhead/Lionhead cross and Dwarf Lop/Dwarf Lop cross). These findings suggest that a breed predisposition for dacryocystitis may exist, particularly for the popular Lionhead and Dwarf Lop rabbits, and veterinarians should advise clients on this accordingly.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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ETHICS STATEMENT

This study was ethically reviewed by the Clinical Research Ethical Review Board at the Royal Veterinary College, and ethical approval was granted under the reference number (URN SR2017-1360).

AUTHOR CONTRIBUTIONS

Conceptualisation, formal analysis, investigation, methodology, supervision and writing (review and editing)—lead; data curation and investigation—supporting. Joanna Hedley. *Data curation, investigation and writing (original draft)—lead; conceptualisation, methodology and writing (review and editing)—supporting.* Victoria Ede. *Conceptualisation, methodology and writing (review and editing)—supporting.* Charlotte Dawson.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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