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**Autor:** Salgado, D. / Reusch, C. / Spiess, B.

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# Diabetic cataracts: Different incidence between dogs and cats

D. Salgado<sup>1</sup>, C. Reusch<sup>2</sup>, B. Spiess<sup>1</sup>

<sup>1</sup>Veterinär-Chirurgische Klinik und <sup>2</sup>Klinik für Kleintiermedizin der Universität Zürich

## Summary

Diabetes mellitus is one of the most common endocrinopathies in the dog and cat. Diabetic cataract primarily affects the canine species and is rarely observed in the cat. It has been proposed that the incidence of cataracts in diabetic dogs is high because many of these patients have significant hyperglycemia despite insulin therapy. Age, gender, levels of serum glucose (before and during insulin therapy) and cataract formation were evaluated, retrospectively, in 23 dogs and 22 cats with diabetes mellitus. In the canine population, the groups with the highest frequency of presentation were females and sexually intact animals. In contrast, males and neutered animals were the most prevalent groups in the feline diabetic population. Over 80 % of diabetic cats and dogs were older than 7 years. Our results confirm the almost total lack of cataracts in diabetic cats, while they were present in more than half of the dogs. A relation between the incidence of cataracts and the correspondent level of hyperglycemia in the canine and feline species could not be established. The estimation of the relative risk for the development of cataracts in diabetic dogs shows that some population groups have a higher probability for suffering from this ocular alteration. A relation between relative risk and the correspondent level of hyperglycemia in the various groups was not found. This fact indicates that other factors are involved in the unequal appearance of diabetic cataracts in dogs and cats.

**Key words:** dogs – cats – diabetes mellitus – cataracts – hyperglycemia

## Zum unterschiedlichen Vorkommen von diabetischen Katarakten bei Hund und Katze

Diabetes mellitus ist eine der häufigsten Endocrinopathien von Hund und Katze. Während die diabetische Katarakt beim Hund sehr häufig auftritt, ist sie bei der Katze äusserst selten. Bislang wurde eine signifikante Hyperglykämie trotz Insulintherapie für die Entwicklung von diabetischen Katarakten beim Hund verantwortlich gemacht. Aus diesem Grund wurden in einer retrospektiven Untersuchung von 23 Hunden und 22 Katzen mit D. mellitus Alter, Geschlecht, Serumglukosespiegel vor und während der Insulintherapie sowie Kataraktentwicklung untersucht. Beim Hund tritt D. mellitus am häufigsten bei intakten Hündinnen auf, während bei der Katze männliche und kastrierte Tiere dominieren. Mehr als 80 % der Hunde und Katzen waren älter als 7 Jahre. Auch in unserem Patientengut kommt die diabetische Katarakt bei der Katze nicht vor, während mehr als die Hälfte der Hunde eine diabetische Katarakt aufwies. Ein Zusammenhang zwischen Katarakt und Glukosespiegel konnte weder bei der Katze noch beim Hund gefunden werden. Einige Subpopulationen der diabetischen Hunde scheinen ein erhöhtes Risiko zu haben, eine Katarakt zu entwickeln. Trotzdem konnte keine Korrelation zwischen relativem Risiko und Glukosespiegel gefunden werden. Unsere Untersuchung zeigt, dass andere Faktoren für die unterschiedliche Inzidenz der diabetischen Katarakt bei diesen zwei Tierarten verantwortlich sein müssen.

**Schlüsselwörter:** Hund – Katze – Diabetes mellitus – Katarakt – Hyperglykämie

## Introduction

Diabetes mellitus is a complex metabolic disorder resulting from impaired or deficient insulin secretion by the pancreatic beta cells or impaired action of insulin in peripheral tissues (Nelson and Feldman, 1988). The incidence of diabetes mellitus is similar for the dog and cat (Panciera et al., 1990).

Dogs with diabetes mellitus are usually 4 to 14 years old, with a peak incidence at 7 to 9 years (Marmor et al., 1982). However, the age-specific risks, reported by Marmor et al. (1982) indicate an increasing risk of diabetes with age. Females are affected about twice as frequently as males (Ling et al., 1977; Marmor et al., 1982). Intact and neutered female dogs are at greater risk than males (Marmor et al., 1982).



Although diabetes mellitus may be diagnosed in cats of any age, the incidence increases with age (Panciera et al., 1990; Kraus et al., 1997). Male cats have a 1.5 times greater risk of developing diabetes mellitus than females. The predominance of diabetes mellitus in neutered males is unique to this species. Independent of age or gender, neutering was documented to double the risk of developing diabetes mellitus in cats (Panciera et al., 1990).

Long-term complications of diabetes affect a variety of ocular tissues including the cornea, lens, and retina (Basher and Roberts, 1995). Cataract formation is the most common and one of the most important long-term complications associated with diabetes mellitus in the dog (Peiffer and Gelatt, 1974; Basher and Roberts, 1995; Nelson, 1995). In diabetic cats, however, ocular signs are uncommon (Nassise, 1991; Basher and Roberts, 1995; Nelson, 1995), early cataract formation is only occasionally observed in diabetic cats (Peiffer and Gelatt, 1974; Nassise, 1991). Additionally, the progression of diabetic cataracts appear to be much slower in the cat than in the dog (Peiffer and Gelatt, 1974; Peiffer et al., 1977).

One explanation for the unequal incidence of cataracts could be based on metabolic differences between both species. The only available information in this respect states that the incidence of cataracts in diabetic dogs is high because many of these patients have significant hyperglycemia despite insulin therapy (Nelson, 1995; Feldman and Nelson, 1996). The aim of the study was to evaluate if there are relevant differences in blood glucose concentrations between dogs and cats. For this purpose age, gender, levels of serum glucose (before and during therapy), and cataract formation were evaluated, retrospectively, in 23 dogs and 22 cats with diabetes mellitus.

**Animals, material and methods**

The medical records of all dogs and cats admitted to the Veterinary Teaching Hospital of the University of Zurich between January 1989 and December 1996 were reviewed to identify dogs and cats with diabetes mellitus. In the present study, records of 23 diabetic dogs and 22 cats are included. The following data were taken for this study and subsequent discussion: age, gender, presence of cataracts and levels of serum glucose. Mean and standard deviation are given. The comparative study of the serum glucose levels “before insulin therapy” between both species included the values obtained the day of the diagnosis and, therefore, before the beginning of the insulin therapy. The comparative study of levels of serum glucose, once the insulin

therapy was initiated (“during insulin therapy”), was made with all the values obtained of all animals during the regular check-ups. The Student's t-test was used to compare differences between the two species groups. The level of significance was set to be  $p < 0.05$ . The serum glucose ranges considered normal in our laboratory for dogs and cats are 4.2 to 5.9 and 2.8 to 7.8 mmol/L in cats, respectively. The relative risk for the presence of cataracts in the different canine diabetic population was calculated as described by Thrusfield (1995).

**Results**

The distribution by sex showed unequal frequencies of presentation of the two categories (male and female) in the canine and feline diabetic populations (Table 1). In the canine species, 17 dogs were females (73.9 %) and 6 males (26.1 %). In contrast, 68.2 % (15 cases) of the diabetic cats were males and 31.8 % (7 animals) females. The analysis of the effect of neutering in diabetic animals showed different frequencies of presentation of the two groups to be studied: sexually intact and neutered. The sexually intact dogs were the most relevant group with 69.6 % (16 dogs). However, in the feline species the neutered animals represent the most important group with 86.4 % (19 cats). Table 1 shows the distribution of the diabetic dog and cat groups by gender (intact males, neutered males, intact females and spayed females). In the diabetic canine population, the female category was the most representative group (47.8 %) and just 4.4 % were neutered males. In contrast, neutered male cats reached 59.1 % whereas intact females represented 4.5 %. Three age ranges were designated: < 7 years old, 7 to 10 years old and > 10 years old. As shown in table 1, the age distribution in the case series was skewed: 69.6 % of the dogs were 7 to 10 years old and 59.1 % of the cats were older than 10 years.

Table 1: Frequencies of presentation of diabetic canine and feline groups by sex, neutering, gender and age, expressed in percentages (s: spayed, n: neutered).

Category		Dog (n = 23)	Cat (n = 22)
<b>Female</b>		73.9% (17)	31.8% (7)
<b>Male</b>		26.1% (6)	68.2% (15)
<b>Sexually intact</b>		69.6 % (16)	13.6% (3)
<b>Neutered</b>		30.4 % (7)	86.4% (19)
<b>Gender</b>	<b>Female</b>	47.8 % (11)	4. % (1)
	<b>Female/s</b>	26.1% (6)	27.3% (6)
	<b>Male</b>	21.7% (5)	9.1% (2)
	<b>Male/n</b>	4.4% (1)	59.1% (13)
<b>Age (years)</b>	< 7	13.0% (3)	4.5% (1)
	7–10	69.6% (16)	36.4% (8)
	> 10	17.4% (4)	59.1% (13)



**Incidence of cataracts and serum glucose levels in diabetic dogs and cats**

The incidence of cataracts between the two species shows a remarkable difference. In the feline population, the incidence was only 5% (1/22), while more than half of the dogs were affected with cataracts (12/23). By the time of diagnosis the dogs had a higher mean blood glucose concentration ( $28.2 \pm 10.5$  mmol/L) than the cats ( $23.1 \pm 5.1$  mmol/L), however, the difference was not significant. The comparative study of levels of serum glucose, once the insulin therapy was initiated, did not indicate any significant differences. Dogs showed a level of  $16.6 \pm 10$  mmol/L, slightly higher than that in cats ( $14.5 \pm 8.4$  mmol/L).

**Relative risk for development of cataracts and serum glucose levels in diabetic dogs**

The relative risks obtained from the analysis of the canine diabetic population, considered as group of risk for the development of cataracts, adjusted by sex, neutering status and age, are shown in table 2. The relative risk for males was 1.42, while females only had a value of 0.7. The levels of serum glucose showed a significant difference ( $p < 0.005$ ); females presented an average of 19.4 mmol/L and males of 14.6 mmol/L.

The castrated dogs had a higher risk (1.14) than sexually intact animals (0.7) for developing diabetic cataracts. The levels of serum glucose were not different between the two groups:  $17.3 \pm 11.3$  mmol/L for sexually intact and  $17.9 \pm 9.5$  mmol/L for neutered dogs. The relative risks obtained for diabetic dogs by gender were: 0.78 for intact females, 1.11 for spayed females, 1.2 for intact males and 2.0 for neutered males, with corresponding blood glucose levels of 19.5, 19.3, 14.0, 16.2 mmol/L. Comparing the four categories statistically, the only significant difference was between intact males-intact

females and intact males-spayed females ( $p < 0.01$ , in both cases).

A positive correlation between the appearance of cataracts and age has also been observed. The risk for the development of cataracts in diabetic dogs increases with age. Cataracts were not reported in any of the younger dogs ( $< 7$  years); however, dogs 7 to 10 years old and those older than 10 years presented a relative risk of 1.31 and 1.58, respectively. The increasing risk with age is related to increased values of blood glucose, being 0 for the dogs younger than 7 years, and blood glucose levels of 15.0, 18.5 and 19.6 mmol/L, respectively. However, a significant difference has been observed between the younger animals ( $< 7$  years) and 7-10 years old dogs only ( $p < 0.05$ ).

**Discussion**

Diabetes mellitus is one of the most common endocrinopathies in dogs and cats (Nelson, 1994). The incidence and epizootiologic patterns in the canine and feline diabetic populations have been the subject of several studies. The most important among these investigations are those by Marmor et al. (1982) in the canine species and Panciera et al. (1990) in the feline species. The comparison of both studies indicates that diabetes mellitus affects the canine and feline populations differently. The results obtained in the present study are in agreement with those described by the aforementioned authors.

In our canine population, the distribution by sex showed a clear inequality: 73.9% of the diabetic animals were females and 26.1% males; thus, the ratio females: males is 2.8 to 1. This proportion, although slightly higher than that reported by Ling et al. (1977) and Marmor et al. (1982), indicates that females are affected more commonly than males. The majority of diabetic cats are males (68.2%). In this species, it has been described that male cats have a 1.5 times greater risk for developing diabetes mellitus than the females (Panciera et al., 1990). Likewise, it is noteworthy that the difference of incidence between the sexual categories was more pronounced in the canine species than in the feline. This observation seems to indicate that sex could have more influence on the development of diabetes mellitus in dogs than in cats.

A significant percentage of diabetic dogs (69.6%) were sexually intact, a result that compares well with the study by Marmor et al. (1982), in which of 1.018 diabetic animals, 642 were intact (63%). By contrast, 86.4% of our diabetic cats were neutered. The analysis of these results indicates that about 9 of 10 cats with diabetes were neutered compared

Table 2: Diabetic dogs with and without cataracts, relative risk, blood glucose levels (mmol/L), and levels of significance obtained comparing the different categories by gender and age in the canine diabetic population (#: no significance).

Category	With/without cataracts	Relative risk	Serum glucose (mmol/L)	Level of significance (Student's t-test)
Female	8/9	0.7	$19.4 \pm 11.1$	
Male	4/2	1.42	$14.6 \pm 8.8$	$p < 0.005$
Sexually intact	8/8	0.87	$17.3 \pm 11.3$	
Neutered	4/3	1.14	$17.9 \pm 9.5$	#
Male	3/2	1.2	$14.0 \pm 9.3$	
Male/n	1/0	2.0	$16.2 \pm 7.5$	#
Female	5/6	0.78	$19.5 \pm 12.0$	$p < 0.01$
Female/s	3/3	1.11	$19.3 \pm 9.6$	$p < 0.01$
< 7	-/3	0	$15.0 \pm 9.7$	
7-10	9/7	1.31	$18.5 \pm 10.8$	$p < 0.05$
> 10	3/1	1.58	$19.6 \pm 10.6$	#



to 3 of 10 in dogs. This fact denotes that neutering in the feline species increases the risk for diabetes, as already reported by Panciera et al. (1990) and Kraus et al. (1997). In addition, in this species the different incidence in the two categories (sexually intact vs. neutered) was more pronounced. This seems to indicate that in the cat neutering could be a stronger risk factor than in the dog.

The distribution followed by the four groups divided by gender is similar to that obtained by Marmor et al. (1982) in the canine species and by Panciera et al. (1990) in feline species. In the diabetic canine population, the group of intact females showed the highest incidence (47.8%), followed by spayed females (26.1%), intact males (9.1%) and intact females (4.5%). Panciera et al. (1990) have reported that other factors might increase longevity in neutered males, compared with sexually intact males, as well as the potential propensity of owners of such cats to seek veterinary care. In contrast, the low incidence of diabetes mellitus in sexually intact female cats could partially be explained by the beneficial effects of estrogen in preventing glucose intolerance and reducing the insulin requirements (Panciera et al., 1990).

It is remarkable that in the group of 7 and 10 years-old dogs 69.9% developed cataracts. This was already described by Marmor et al. (1982). However, the same authors, comparing the diabetic canine population in relation to the control population, reported how the risk of diabetes increases with age in dogs. In the feline species, the results clearly denote how cases of diabetes mellitus are increasing with age. Panciera et al. (1990) suggest that a degenerative process or development of endogenous diabetogenic factors could be responsible. In cats, an age-related reduction in  $\beta$ -cell function, which may enhance susceptibility to the effects of diabetogenic factors, might exist. In addition, the incidence of many factors that cause insulin resistance in human beings and other species, develop most commonly in older cats (Panciera et al., 1990).

#### **Incidence of cataracts and serum glucose levels in diabetic dogs and cats**

The results obtained in the present study confirm the almost total lack of cataracts in diabetic cats. In the canine population, more than half of the diabetic dogs develop cataracts (52.2%), while in cats the incidence of this ocular alteration does not reach more than 5%. As a matter of fact, the only cataractous cat with diabetes mellitus was 15 years old. An explanation for the lower incidence of diabetic cataracts in cats could be that in this species diabetes mellitus is associated with lower levels of blood glucose. Thus, a smaller increase of aqueous humor

and lenticular glucose concentrations would cause a slower progression of cataracts (Peiffer and Gelatt, 1974; Peiffer et al., 1977). Feldman and Nelson (1996) report that the incidence of cataracts in diabetic dogs is high because many of these patients have significant hyperglycemia despite insulin therapy. In general, dogs with diabetes mellitus show a level of serum glucose slightly higher than cats, although the results do not prove that this difference could be the only cause of low incidence of diabetic cataracts in the feline species.

#### **Relative risk for development of cataracts and serum glucose levels in diabetic dogs**

The estimation of the relative risk for the development of cataracts in diabetic dogs shows that some population groups have a higher probability for suffering this ocular alteration. An explanation for this variation between some groups could be that the levels of serum glucose is different. As Feldman and Nelson (1996) reported, higher rates of glucose are associated with a higher incidence of cataracts. A positive statistical association between males and the development of cataracts has been found. These results could be associated with higher blood glucose levels in males than in females; however, the opposite was shown. The study of neutering as risk factor for development of cataracts in the diabetic canine population has shown no relevant results. The relative risk obtained for diabetic dogs by gender is not related with serum glucose levels. Although the increase of the risk with age is accompanied by increased average values of blood glucose, there is no statistical difference in glucose levels between younger dogs and the older dogs (> 10 years) and between 7 to 10 years old dogs and dogs older than 10 years. This shows that other factors must be involved.

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**Cataracte diabétique: Incidence différente entre les chiens et les chats**

Le diabète sucré est une des endocrinopathies les plus communes chez le chien et le chat. La cataracte diabétique touche principalement l'espèce canine et n'est que rarement observée chez le chat. Il a été proposé que l'incidence de la cataracte chez les chiens diabétiques est élevée parce que plusieurs de ces patients ont une hyperglycémie malgré une thérapie au moyen d'insuline. L'âge, le sexe, les concentrations du glucose sérique (avant et durant la thérapie au moyen de l'insuline) et la formation de cataracte ont été évalués rétrospectivement chez 23 chiens et 22 chats atteints de diabète sucré. Au sein de la population canine, les groupes avec la fréquence la plus élevée étaient les femelles et les animaux sexuellement intacts. Par contre, les mâles et les animaux castrés étaient caractérisés par une fréquence plus élevée dans la population diabétique féline. Plus 80% des chats et des chiens diabétiques étaient âgés de plus de 7 ans. Nos résultats confirment l'absence presque totale de cataracte chez les chats diabétiques alors qu'elles étaient présentes chez plus de la moitié des chiens. Une relation entre l'incidence des cataractes et le niveau correspondant d'hyperglycémie au sein de l'espèce canine et féline ont été établis. L'estimation d'un risque relatif pour le développement de cataracte chez les chiens diabétique démontre que certains groupes sont caractérisés par une plus forte probabilité d'être atteint par cette affection de l'œil. Une relation entre le risque relatif et le niveau correspondant d'hyperglycémie au sein des différents groupes n'a pas été révélée. Ce fait indique que d'autres facteurs sont impliqués dans la prépondérance inégale de cataractes diabétiques chez les chiens et les chats.

**Differente apparizione di cataratte causate dal diabete nel cane e nel gatto**

Il diabete mellito è una delle patologie endocrine riscontrate più frequentemente nel cane e nel gatto. La cataratta da diabete, molto rara nel gatto, viene riscontrata di frequente nel cane. Un'iperglicemia significativa malgrado terapia con insulina è stata finora ritenuta la causa della cataratta da diabete nel cane. Per questa ragione in un studio retrospettivo comprendente 23 cani e 22 gatti con d. mellito sono stati esaminati l'età, il sesso, il tasso di glucosio nel siero prima e durante la terapia con insulina, come pure lo sviluppo di cataratta. Nel cane il d. mellito viene riscontrato con frequenza maggiore nelle cagne intatte, mentre nel gatto dominano gli animali maschi e quelli castrati. Più dell'80 % dei cani e dei gatti avevano un'età maggiore di 7 anni. Anche fra i nostri pazienti la cataratta da diabete non viene riscontrata nei gatti, mentre la metà dei cani presenta una cataratta causata da diabete. Sia nel gatto che nel cane non è stata riscontrata alcuna relazione tra la cataratta e il tasso di glucosio. Alcune subpopolazioni di cani diabetici sembrano avere un rischio maggiore di sviluppare la cataratta. Malgrado ciò non è stata riscontrata alcuna correlazione fra rischio relativo e tasso di glucosio. Il nostro studio mostra che altri fattori sono responsabili per la differente incidenza della cataratta da diabete in queste due specie animali.

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**Address of correspondence**

Prof. Dr. Bernhard Spiess, Veterinär-Chirurgische Klinik der Universität Zürich  
Winterthurerstrasse 260, CH-8057 Zürich, E-mail: bspiess@vetchir.unizh.ch

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