


ORIGINAL RESEARCH

Tumours in 177 pet hamsters

Nancy Rother¹  | Christof A. Bertram² | Robert Klopffleisch² |
Marco Fragoso-Garcia² | Wolf V. Bomhard³ | Claudia Schandelmaier⁴ |
Kerstin Müller⁵

¹ Tierärztliche Praxis für Heimtiere Dr. Lazarz, Duisburg, Deutschland

² Institute of Veterinary Pathology, Freie Universität Berlin, Berlin, Deutschland

³ Fachpraxis für Tierpathologie, München, Deutschland

⁴ LABOKLIN GmbH & Co. KG, Labor für klinische Diagnostik, Bad Kissingen, Deutschland

⁵ Small Animal Clinic, Freie Universität Berlin, Berlin, Deutschland

Correspondence

K Müller, Small Animal Clinic, Freie Universität Berlin, Berlin, Deutschland.

Abstract

Background: Even though tumours are considered to occur frequently in pet hamsters, there is only a small number of scientific reports in current literature.

Methods: Pathological reports from 177 hamsters were evaluated.

Results: Of these, 78 were male and 75 were female. Median age of affected hamsters was 12 months (range 2–34). Integumental tumours were the most common neoplasms (62%, 109/177). As far as species was known, the number of Syrian hamsters (52%, 30/58) affected by tumours seemed to be lower than the number of affected dwarf hamsters (85%, 47/55). Tumours of the hematopoietic system were the second most frequently neoplasms (17%, 30/177). Relative number of neoplasms of the endocrine system, tumours of the digestive system (1.7%, 3/177) and other tumours (4%, 7/177 each) was low. The majority of integumental tumours were epithelial (66%; 91/126).

Conclusion: This study aimed to analyze data from veterinary surgeries and pathological institutes about the occurrence of spontaneous tumours in Syrian hamsters and dwarf hamsters to give information about the frequency of tumours, prognosis and survival time. This is the first study about tumours in pet hamsters in Germany so far.

KEYWORDS

dwarf hamster, neoplasms, small mammals, Syrian hamster

INTRODUCTION

Hamsters belong to the order of rodents (Rodentia) and are very popular as pets. The most common species is the Syrian or golden hamster (*Mesocricetus auratus*).¹ Dwarf hamsters include the Djungarian hamster (*Phodopus sungorus*), the Campbell's dwarf (*Phodopus campbelli*) the Roborovskii hamster (*Phodopus roborovskii*) and the Chinese hamster (*Cricetulus griseus*). The average lifespan varies from 24 to 36 months depending on the species.¹

While scientific reports on tumours of laboratory hamsters are common, reports on tumours of pet hamsters are uncommon. Most of them are case reports about tumours of the hematopoietic system (lymphoma, mastocytoma) and mesenchymal tumours (mostly cutaneous haemangiosarcoma) with a small number of animals.^{2–5} Only one study from Japan deals with a higher number of spontaneously occurring tumours in 85 pet hamsters. The authors report that Djungarian hamsters were almost exclusively affected by integumental neoplasms (mam-

mary tumours, atypical fibroma, papilloma), whereas Syrian hamsters commonly suffered from hematopoietic tumours (plasmocytoma, lymphoma).⁶

The present study's aim was to investigate the affected organ system and tumour type of naturally occurring tumours in pet hamsters kept in Germany with a large sample of data. Treatment outcome was available for some of cases.

MATERIALS AND METHODS

For this retrospective study data of tumours in 177 pet hamsters, examined at the Institute of Veterinary Pathology of Freie Universität Berlin (n = 24, between 2005 and 2019), the Fachpraxis für Tierpathologie von Bomhard in Munich (n = 62, between 2015 and 2019), the Labor für klinische Diagnostik der Firma LABOKLIN GmbH & Co. KG (n = 83, between 2005 and 2019) and IDEXX Laboratories (n = 8, between 2010 and 2019) were analyzed. The samples, including biopsy specimen or entire animal bodies, were submitted

by German veterinary practices between 2005 and 2019. Material of excisions (biopsy specimen, entire tumours) from 172 patients was examined as well as section material of five animals. The samples were fixed, stained and sectioned according to standard histopathologic methods.

Collected data included species, age, sex, tumour localization and survival time after surgery. In a few cases where information about the exact species was not recorded, it was possible to differentiate between adult Syrian hamster and dwarf hamster considering the body weight. Patients with a body weight of over 80 g were supposed to be Syrian hamsters, whereas patients with a body weight of less than 40 g were supposed to be dwarf hamsters.

The results were evaluated comparatively between the Syrian hamster and dwarf hamster. In 64 cases information about the exact species was lacking. Therefore they were not included in the comparison of tumour frequency in these two hamster species. In the cases of surgical biopsies, we tried to obtain information about the patients' survival time. Therefore, a questionnaire was forwarded to the submitting veterinarians and analyzed after retrieving.

The histological classification of the tumour type was based on current guidelines.^{7,8} Neoplasms were divided into integumental tumours, tumours of the hematopoietic, reproductive, endocrine or digestive system and other tumours. Tumours of the mammary glands were included in the integumental neoplasms. Tumours of the integumentary system were subdivided into epithelial and mesenchymal (Table 1). Tumours with adnexal differentiation included neoplasms of the sebaceous glands, follicular tumours and apocrine gland tumours. Neoplasms located in the abdomen which could not be allocated to the reproductive system as well as tumours which could not be allocated in any of the other groups were assigned as other tumours.

RESULTS

A total of 177 tumours were detected in 58 Syrian hamsters and 55 dwarf hamsters (30 Djungarian hamsters, three Campbell's dwarfs, three Roborovskii hamsters, one Chinese hamster, species not reported in 18 cases). In 64 animals it was impossible to assign them either to Syrian or to dwarf hamsters due to lacking data.

Of 177 affected hamsters, 78 were male (21 Syrian hamsters, 27 dwarf hamsters, and 30 of unreported species) and 75 were female (33 Syrian hamsters, 24 dwarf hamsters, and 18 of unreported species). Sex was not reported for 24 hamsters.

The median age ($n = 146$) was 12 months (range 2–36). The median age of affected Syrian hamsters ($n = 50$) was 12 months (range 2–36). The median age of dwarf hamsters ($n = 44$) was 13 months (range 4–36). The median age of Djungarian hamsters ($n = 27$) was 12 months (range 4–36). The affected Campbell's dwarfs were 12, 18 and 28 months old. The Roborovskii

hamsters of known age were recorded to be 18 and 24 months old, the Chinese hamster was 16 months old.

Integumentary system

The predominant localization of tumours was the integument (71%; 126/177). Altogether 85% (47/55) of the examined dwarf hamsters and 52% (30/58) of the Syrian hamsters had integumental tumours. As far as sex was reported, the relative frequency of integumental tumours was similar for female hamsters (55/105) and male hamsters (50/105). The median age of hamsters with integumental tumours was 12 months (range 4–36). The median age in Syrian hamsters was 13 months and 12 months in dwarf hamsters. The most common integumental tumours were epithelial tumours (66%; 91/126), whereas 21% (27/126) of the neoplasms were characterized as mesenchymal (Figure 1A,B). Of 126 integumentary tumours, 59% (74/126) were benign, and 41% (52/126) were malignant. Epithelial tumours were predominantly characterized as benign (76%, 69/91) and only 24% (22/91) were malignant. On the contrary, 96% (26/27) of the mesenchymal tumours were malignant. The exact localizations of integumental tumours are shown in Table 1.

There were 22 different types of integumental tumours, of which 12 were benign and 10 were malignant. Epithelial neoplasms included 81% (74/91) of tumours with adnexal differentiation and 16% (15/91) of tumours of the epidermis. Only 2% (2/91) were epithelial tumours without squamous or adnexal differentiation. Two male dwarf hamsters (2%, $n = 126$) were diagnosed with adenomas of the ventral abdominal marking gland. Of integumental neoplasms, 13% (17/126) were mammary tumours. Most of the mammary tumours were found in dwarf hamsters (59%, 10/17) and less common in Syrian hamsters (12%, 2/17). The exact hamster species was not reported in 29% (5/17) of the mammary tumours. All tumours were found as subcutaneous masses located on the chest and the ventral abdomen. The most common type of mammary tumours were adenocarcinoma (52%, 9/17), followed by adenoma (35%, 6/17) and fibroadenoma (12%, 2/17). One of the adenomas revealed signs of transformation to adenocarcinoma. (Figure 1C)

Hematopoietic system

Hematopoietic tumours were diagnosed in 17% (30/177) of tumours, affecting 14 males and 14 females (for two sex unknown) and mainly Syrian hamsters (87%, 20/23) of samples with known species. Dwarf hamsters were less commonly involved (13%, 3/23). The median age of all hamsters was 12 months (range 2–36), of Syrian hamsters 11 months (range 2–36) and the only dwarf hamster of known age was 30 months old. Of the affected hamsters, 33% (6/18) were maximum 6 months old. Lymphoma was the main

TABLE 1 Overview of integumental tumours (n = 126) with type of tumour, localization, species and sex of affected hamsters

Histopathologic diagnosis	N	Head	Limb	Tumour localization					Mamma	U	Species SH	DH	U	Sex m	f	U
				Thorax	Abdomen	Back	Back	Mamma								
Epithelial	91															
Tumours of the epidermis	15															
Papilloma	10	4	5	1						1	6	3	8	2		
Squamous cell carcinoma	5	4	1							1	2	2	2	2	1	
Follicular tumours	43															
Trichoepithelioma	29	14	4	2	3					6	2	15	12	10	7	
Trichoblastoma (malignant)	1	1								1			1			
Trichofolliculoma	12	3	1	1	1					6	2	7	4	6	2	
Pilomatricoma	1		1							1	1			1		
Sebaceous gland tumours	5															
Sebaceous gland adenoma	3	1								2	2	1	1	1	1	
Sebaceous gland epithelioma	1									1		1	1			
Sebaceous gland carcinoma	1				1					1			1			
Apocrine gland tumours	26															
Fibroadenoma	4			1	1					2	3			4		
Adenoma	9			1	2					6	6	2	2	6	1	
Carcinoma	4			2	1					1	3	1	2	1	1	
Adenocarcinoma	9									9	6	2		8	1	
Other	2															
Basal cell carcinoma	2	2											2			
Mesenchymal	27															
Fibroma	1			1								1	1			
Fibrosarcoma	9	4	3	1						1	3	4	5	4		
Myxosarcoma	3	2								1	1	2	1	1	1	
Sarcoma	12	1		7						3	5	5	4	3	5	
Haemangiosarcoma	2	2									2		1			
Melanocytic tumours	7															
Malignant melanoma	4	2			1						1	1	1	3		
Melanocyoma	3	2									1	1	1		2	
Round cell tumours	1															
Histiocytoma	1			1										1		

Abbreviations: DH, dwarf hamster, f, female, m, male, SH, Syrian hamster, U, unknown.

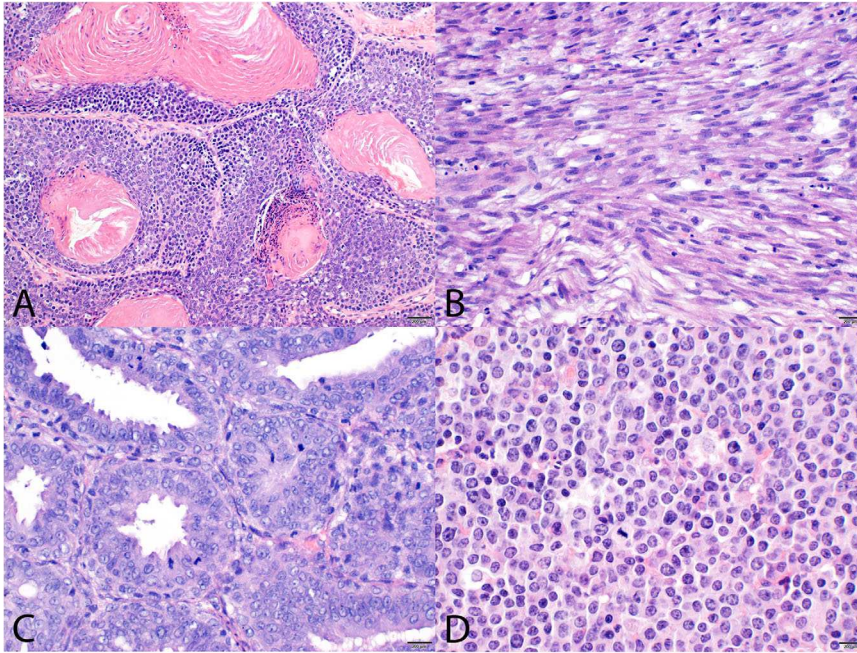


FIGURE 1 Histological images of relevant tumours in hamsters. (A) Skin, trichoepithelioma. (B) Skin, fibrosarcoma. (C) Mammary gland, simple carcinoma. (D) Lymph node, lymphoma

diagnosis (83%, 25/30) (Figure 1D). In case the exact species was reported, exclusively Syrian hamsters were affected ($n = 19$). Mast-cell tumours were observed in 13% (4/30) of the hamsters, including three dwarf hamsters (two Djungarian hamsters, one dwarf hamster of unrecorded species). Mediastinal thymoma was found in one Syrian hamster. As far as the localization was noted, 75% (21/28) of hematopoietic tumours were found as cutaneous or subcutaneous masses. Half of these neoplasms were located on the head and neck (52%, 11/21). Most of lymphomas were located on the head and neck (72%, 18/25). All remaining lymphomas were found intraabdominal (16%, 4/25), retrobulbar (4%, 1/25), intratesticular (4%, 1/25), and the location of one (4%, 1/25) was unknown. Of the mast cell tumours, 75% (3/4) were found as cutaneous masses, and the location of one mast cell tumour was unknown (25%, 1/4). The localization was not reported in 7% (2/30) of cases of hematopoietic tumours due to missing data on the submitted questionnaire.

Primary tumours of the reproductive system

Primary tumours of the reproductive system occurred in 1.7% (3/177) of the hamsters. These neoplasms were exclusively observed in female Syrian hamsters (100%, 3/3). Diagnoses were papilloma of the cervix (age: 18 months), leiomyosarcoma of the uterus (age: 24 months) and squamous cell carcinoma of the mesometrium (age: 15 months). It could not be specified, if the squamous cell carcinoma was a metastasis.

Tumours of the endocrine system

Tumours of the endocrine system were diagnosed in 4% of the hamsters (7/177), four males and three females. The median age was 14 months (range

9–18). Of the samples with known species, Syrian hamsters were affected in 75% (3/4) and one Djungarian hamster. Carcinoma of the thyroid gland was the main diagnosis (86%, 6/7). These tumours were found as masses located on the ventral neck and the cranial thorax. A male hamster of unknown species had an adenoma of the pituitary gland.

Digestive system

Neoplasms of the digestive system were rare (1.7%, 3/177). Fibrosarcoma and fibromyxosarcoma were diagnosed as cheek pouch tumours in a 16 months old male Chinese hamster and a 21 months old female Syrian hamster. A mass on the neck of an 18 months old male Syrian hamster was identified as an adenocarcinoma of the salivary gland. These were the only tumours of the digestive system found in this study.

Other tumours

Other tumours were identified in 4% (7/177) of the hamsters. Mainly males were affected (71%, 5/7). The median age was 18 months (range 8–36). Only Djungarian hamsters were affected in samples where the species was known ($n = 3$). The age of the Djungarian hamsters was 12, 18 and 20 months. In 71% (5/7) intraabdominal carcinoma was diagnosed. In two Djungarian hamsters (40%, 2/5), the origin of the carcinoma was the kidney, and the origin of the other carcinomas could not be determined. Twenty-nine per cent (2/7) of the described tumours were sarcomas, an osteosarcoma of the foreleg and an intraabdominal myxosarcoma in hamsters of unknown species.

Survival time

The survival time after surgery was recorded in 31 of 177 cases and varied between 0 and more than 672

TABLE 2 Survival time in days depending on type of tumour and localization in 31 hamsters

Localization	Histopathologic diagnosis	Survival time
Integument	Squamous cell carcinoma	63
	Squamous cell carcinoma	30
	Haemangiosarcoma	140
	Adenoma	280 +
	Adenoma	588
	Fibroadenoma	280
	Fibrosarcoma	30
	Sebaceous gland carcinoma	60
	Carcinoma	504 +
	Carcinoma	672
	Trichoblastoma	420
	Trichofolliculoma	700
	Trichofolliculoma	280
	Trichoepithelioma	98
	Melanocytoma	672 +
	Histiocytoma	448 +
	Adenoma (mammary gland)	140
	Adenoma (mammary gland)	140 +
	Fibroadenoma (mammary gland)	168 +
	Adenocarcinoma (mammary gland)	60
	Adenocarcinoma (mammary gland)	0
	Adenocarcinoma (mammary gland)	120
	Hematopoietic system	Lymphoma
Lymphoma		10 +
Lymphoma		0
Reproductive tract	Squamous cell carcinoma (Mesometrium)	2
Endocrine system	Carcinoma (thyroid gland)	30
	Carcinoma (thyroid gland)	168 +
Digestive tract	Adenocarcinoma (salivary gland)	30
Other tumours	Carcinoma (kidney)	168
	Carcinoma (kidney)	1

+, Patient was still alive at time of data collection.

0, Patient died prior/during or shortly after surgery/got euthanized intra operationem.

days. A summary is given in Table 2. The median survival time of hamsters with integumental tumours was 350 days, and the median survival time of patients with tumours of the reproductive system was 120 days. Three hamsters died prior, during or shortly after surgery or were euthanized immediately. In the remaining cases (n = 28), the post-surgical recovery was uneventful.

DISCUSSION

Syrian hamsters and Djungarian hamsters are the most common species of pet hamsters, therefore the number of affected animals of these species was markedly higher than the number of other dwarf hamsters. Therefore predisposition for certain tumours in underrepresented species such as Campbell's dwarfs, Roborovski hamsters cannot be assumed. Comparable numbers of samples of Syrian and dwarf hamsters made comparison of tumour occurrence in these species possible.

We suppose that in this study externally located, obvious tumours such as integumental neoplasms are overrepresented because these tumours undergo surgery more frequently, and submission of a sample to a laboratory is more likely.

Data about frequency of spontaneously occurring tumours in laboratory hamsters vary.⁹⁻¹² The present study found a slightly higher frequency of tumours in pet dwarf hamsters than in pet Syrian hamsters. Kondo et al had similar results. Some studies found more tumours in females than in males.^{6,13-15} This is in contrast to our results, where, as far as sex was known, males and females were affected almost similar. The median age of hamsters in the present study was 12 months. A comparable study about spontaneous tumours in pet hamsters determined a median age of 19.8 months.⁶ The occurrence of tumours in laboratory hamsters younger than 12 months is rare.¹⁵ According to laboratory studies, the chance of tumour growth for both sexes increases markedly after the first year of age.¹² This does not accord with our results. More than half of the examined hamsters where age was recorded were maximum 12 months old. It is however not clear if the submitted samples reflect the real frequency of spontaneous tumours in older or younger hamsters. According to other studies, integumental neoplasms including tumours of the mammary glands have been reported more frequently in younger patients, whereas tumours of the kidneys have only been observed in patients older than 22 months.^{5,6} This was consistent with our results. Yoshimura et al reported that in a colony of laboratory Djungarian hamsters, the age of the animals with benign mammary gland tumours was lower than that of the hamsters with malignant types. This fact could not be confirmed by our study. Neither Kondo et al nor our study could detect a coherence between age of the hamsters and dignity of tumours.

Integumentary system

In the present study, integumental neoplasms were the most common type of tumour. The number of affected dwarf hamsters was insignificantly higher than the number of affected Syrian hamsters. A markedly higher number of integumental tumours in dwarf hamster, as Kondo et al reports, could not be observed.

The existence of multiple tumours as reported by these authors could also not be detected.

Various studies revealed papilloma and squamous cell carcinoma with an incidence of 7% in laboratory Syrian hamsters.^{10,16} The present study determined more than twice the number of cases. In the present study, the masses were located almost solely in the epidermis of the head and the extremities, in conformity with Kondo et al. The appearance of trichoepithelioma is considered to be pathognomonic for an infection with hamster polyomavirus.¹¹ Further examination of trichoepithelioma has not been done in this study.

Neoplasms of the paired marking glands on the flank (Syrian hamsters) and the ventral abdominal marking glands (dwarf hamsters) occur frequently. Melanomas of the skin and the marking glands were found frequently in one study about Syrian hamsters.¹⁴ This could not be confirmed by our study. In their study with laboratory Syrian hamsters, Van Hoosier and Trentin assigned that the incidence of these tumours in males was 10 times higher than in females. In the present study, tumours of the marking glands were rare; they only occurred in male dwarf hamsters and were identified as adenoma.

According to literature, tumours of the mammary glands are rare in hamsters, which was confirmed by the present study.^{6,17} The number of affected dwarf hamsters was markedly higher than the number of Syrian hamsters, consistent with a previous study.¹⁸ Kondo et al reported that mammary tumours predominantly affect females, which could be confirmed by the present study. In the present study almost half of the mammary tumours were malignant. The proportion of malignant mammary tumours varies somewhat in the previous studies. While some authors report that mammary tumours are predominantly benign,^{10,19} another study showed a significantly high number of malignant tumours of the mammary gland.²⁰

The observed frequency of mesenchymal tumours was low in comparison to epithelial tumours, which is confirmed by Kondo et al. Contrary to existing literature, melanocytic tumours were uncommon in our study.⁶ In conformity with other publications, a sex predilection for these tumours could not be determined.^{21,22} The masses were predominantly located on the head. Cutaneous haemangiosarcomas are rare and scarcely reported in literature.² The median age was, consistent with Kondo et al, slightly higher in hamsters affected by mesenchymal tumours than in hamsters affected by epithelial neoplasms.⁶

Hematopoietic system

Tumours of the hematopoietic system occur frequently in hamsters. Most of them are characterized as lymphoma, the most common type of tumour in Syrian hamsters.^{23,24} This could not be verified with the present study. Differing from the results of Kamino, Tillmann and Mohr, no sex predilection for the appearance of lymphoma could be detected. According to Toft, depending on the variation of lym-

phoma, involvement of the peripheral lymphnodes, the skin and the internal organs can be detected. Other authors found the tumours in the liver, spleen and gastrointestinal tract.¹¹ As shown in the present study, lymphoma can also be found in the testes.²⁵ Harvey et al reported about six Syrian hamsters diagnosed with cutaneous, epitheliotropic lymphoma, specified as T-cell-lymphoma.

Tumours of the hematopoietic system rarely occur in dwarf hamsters, which could be confirmed by both the present study and Kondo et al. Whereas reports about lymphoma in dwarf hamsters are lacking, mast cell tumours, predominately found as cutaneous or subcutaneous masses, are sporadically mentioned in literature.⁴ This does accord with our results.

One type of lymphoma in hamsters, the transmissible, epizootic variation, is caused by Hamster Polyomavirus (HaPyV), which can be found commonly in laboratory hamsters as well as in some sources of pet hamsters. Affected hamsters often show lymphoid or follicular tumours such as trichoepitheliomas. Especially in older hamsters, it can appear subclinically. Experts suggest that lymphoma arising in animals less than two years of age is due to infection with HaPyV.²⁶ Although no further analysis such as PCR (polymerase chain reaction) has been done in this study to identify the virus, the authors suspect that detected lymphomas in the hamsters younger than 6 months of age were caused by HaPyV. Barthold, Griffey and Percy also report that the appearance of trichoepithelioma is pathognomonic for infection with HaPyV. The present study detected a large number of trichoepitheliomas in hamsters at any age, so these are suspected to be caused by infection with HaPyV as well.

Primary tumours of the reproductive system

Primary tumours of the reproductive system mentioned in literature and partly detected in our study as well were for example leiomyoma, leiomyosarcoma, endometrial polyps, adenocarcinoma of the uterus and ovarian tumours.^{6,27} Up to now there are no reports about spontaneous tumours of the testes as well as squamous cell carcinoma of the mesometrium as detected in the present study. It is unknown, if the tumour in the mesometrium was a primary tumour or a metastasis.

Tumours of the endocrine system

Bauk et al describe the appearance of an adenoma of the pituitary gland in pet long-haired hamsters. An adenoma of the pituitary gland could also be detected in one of the hamsters in the present study. This type of tumour is potentially/likely underrepresented in our study due to the fact that the majority of samples consisted from biopsies and surgically removed masses. But this tumour is predominantly

identified only through postmortem examinations. Tumours of the thyroid gland were rare, and exclusively carcinoma could be observed. Even in literature reports about these tumours are very sporadic.^{28,29} In Syrian hamsters the probability of occurrence increases with age.²⁹ According to a study about laboratory Djungarian hamsters predominantly patients between 1 and 2 years of age were affected. In all patients the tumour involved both sides of the thyroid gland and metastasized rarely in the lungs.²⁸

Digestive system

Various types of neoplasms developing from the digestive system have been mentioned in literature.^{10,21,30,29,31} In conformity with previous reports about neoplasms of the cheek pouch only fibrosarcoma and fibromyxosarcoma could be identified in the present study.^{32,33}

Neoplasms of the lower digestive system could not be observed in the present study. The authors assume that this is due to the type of examined samples (predominantly biopsies), but even in literature reports about tumours of the gastrointestinal tract are rare.^{10,21,30}

Other tumours

Other tumours are considered rare.^{6,34} Kirkman and Algard report about primary tumours of the kidneys. They were identified as adenocarcinoma, similar to the two cases detected in the present study, and nephroblastoma. A hormon-dependent development of tumours of the kidneys has been discussed.¹² In addition to the intraabdominal epithelial and mesenchymal neoplasms observed in the present study, Kirkman and Algard report about haemangioma located in the liver and spleen.

Survival time

Data about the survival time of hamsters after tumour-surgery have previously only been reported for laboratory hamsters.^{3,35} According to Fortner, George and Sternberg, only 1.5 % of the hamsters affected by a carcinoma of the thyroid gland survived longer than 161 days. In the present study, the survival time for these types of tumours was recorded in two cases. One patient survived 30 days, the other one was still alive when outcome was assessed 168 days after surgery. In patients suffering from lymphoma, the average survival time between the first veterinary consultation and euthanasia was 9.6 weeks, which significantly exceeded the survival time of patients in our study.³ The present study showed that of those tumours where survival time is reported, hamsters with special types of integumental tumours (adenoma, histiocytoma, two carcinomas and a melanocytoma) survived remarkably long. But because of the small number of


cases where survival time is recorded, the informative value about this for totality of these tumours is not clear. It can be determined, that, as far as known, most of the hamsters initially survived the surgery. To give significant information about the survival time of hamsters affected by a particular type of tumour, further studies with a large number of cases per tumour type are necessary.

It is possible that the tumour occurrence in the present study does not completely represent the natural frequency of spontaneous tumours in the population of pet hamsters in Germany due to the submission to a Pathological Institute being an important influencing factor.

This is the first study about tumours in pet hamsters in Germany so far. A related study from Japan revealed many similarities, but also numerous differences.⁶ Further studies with a larger amount of cases are necessary to make a possible statement about tumour incidence, prognosis and survival time.

Both Syrian hamsters and dwarf hamsters can be affected by various types of tumours. Whereas dwarf hamsters are more likely to be diagnosed with integumental tumours, Syrian hamsters often show tumours of the hematopoietic system, especially lymphoma. There was no remarkable difference between dwarf hamsters and Syrian hamsters regarding the age and sex predilection of particular tumours. A few tumours detected in the present study are not reported for these species yet. To create a greater data pool it is necessary that more veterinarians do tumour surgery or even fine needle aspirations in hamsters and submit the samples to Pathological Institutes so they can get analysed.

ORCID

Nancy Rother  <https://orcid.org/0000-0003-4476-825X>

REFERENCES

1. Lennox AM, Bauck L. Small rodents. In: Quesenberry KE, Carpenter JW, editors. Ferrets, rabbits and rodents – clinical medicine and surgery. St. Louis, MO: Elsevier; 2012. p. 339–72.
2. Rosenthal K. Hemangiosarcoma in a hamster. *J Small Exot Anim Med.* 1991;1:15.
3. Harvey RG, Whitbread TJ, Ferrer L. Epidermotropic cutaneous T-cell lymphoma (mycosis fungoides) in Syrian hamsters (*Mesocricetus auratus*). A report of six cases and the demonstration of T-cell specificity. *Vet Dermatol.* 1992;3:13–9.
4. Nishizumi K, Fujiwara K, Hasegawa A. Cutaneous mastocytomas in Djungarian hamsters. *Exp Anim.* 2000;49:127–30.
5. Pogozianz HE, Sokova OI. Tumours of the Djungarian hamster. In: Turusov VS, editor. Pathology of tumours in laboratory animals. vol. 3. Tumours of the Hamster. Lyon, France: IARC Scientific Publications; 1982. p. 451–5.
6. Kondo H, Onuma M, Shibuya H, Sato T. Spontaneous tumors in domestic hamsters. *Vet Pathol.* 2008;45:674–80.
7. Goldschmidt MH, Dunstan RW, Stannard AA. Histological classification of epithelial and melanocytic tumors of the skin of domestic animals, vol. 3. Washington DC: Armed Forces Institute of Pathology; 1998.
8. Mohr U. International classification of rodent tumors. Berlin, Heidelberg: Springer-Verlag; 2001.
9. Karolewski B, Mayer WT, Ruble G. Non-infectious diseases. In: Suckow MA, Stevens KA, Wilson RP, editors. The laboratory

- rabbit, guinea pig, hamster, and other rodents. Oxford: Elsevier; 2012. p. 867–73.
10. Kamino K, Tillmann T, Mohr U. Spectrum and age-related incidence of spontaneous tumours in a colony of Han:AURA hamsters. *Exp Toxic Pathol.* 2001;52:539–44.
 11. Strandberg JD. Neoplastic diseases. In: van Hoosier GL, Jr, McPherson CW, editors. *Laboratory hamsters.* New York: Academic Press; 1987. p. 157–68.
 12. Kirkman H, Algard FT. Spontaneous and nonviral-induced neoplasms. In: Hoffmann RA, Robinson PF, Magahaes H, editors. *The golden hamster, its biology and use in medical research.* Ames, IA: Iowa State University Press; 1968. p. 227–40.
 13. Harkness JE, Wagner JE. Specific diseases and conditions. In: Harkness JE, Wagner JE, editors. *The biology and medicine of rabbits and rodents.* Philadelphia, PA: Williams and Wilkins; 1995. p. 171–322.
 14. Van Hoosier GL, Jr, Trentin JJ. Naturally occurring tumors of the Syrian hamster. *Prog Exp Tumor Res.* 1979;23:1–12.
 15. Pour P, Birt D. Spontaneous diseases of Syrian hamsters - their implications in toxicological research: Facts, thoughts and suggestions. *Prog Exp Tumor Res.* 1979;24:145–56.
 16. Valentine H, Daugherty KE, Singh B. The experimental use of Syrian hamsters. In: Suckow MA, Stevens KA, Wilson RP, editors. *The laboratory rabbit, guinea pig, hamster, and other rodents.* Oxford, UK: Elsevier; 2012. p. 875–906.
 17. Pogozianz HE. Djungarian hamster - a suitable tool for cancer research and cytogenetic studies. *J Natl Cancer Inst.* 1975;54:659–64.
 18. Kondo H, Onuma M, Shibuya H, Sato T. Morphological and immunohistochemical studies of spontaneous mammary tumours in Siberian hamsters (*Phodopus sungorus*). *J Comp Pathol.* 2009;140:127–31.
 19. Toft JD. Commonly observed spontaneous neoplasms in rabbits, rats, guinea pigs, hamsters and gerbils. *Sem Avian Exot Pet Med.* 1992;1:80–92.
 20. Yoshimura H, Kimura-Tsukada N, Ono Y, Michishita M, Ohkusu-Tsukada K, Matsuda Y, et al. Characterization of spontaneous mammary tumors in domestic Djungarian hamsters (*Phodopus sungorus*). *Vet Pathol.* 2015;52:1227–34.
 21. Fortner JG. Spontaneous tumors including gastrointestinal neoplasms and malignant melanomas, in the Syrian hamster. *Cancer.* 1957;10:1153–6.
 22. Fortner JG, Allen AC. Comparative oncology of melanomas in hamsters and man. In: Gordon M, editor. *Pigment cell biology.* New York: New York Academic Press; 1959. p. 85–98.
 23. Ernst H, Kunstyr I, Rittinghausen S, Mohr U. Spontaneous tumours of the European hamster (*Cricetus cricetus* L.). *Z Versuchstierkd.* 1989;32:87–96.
 24. Strauli P, Mettler J. Tumours of the haematopoietic system. In: Turusov VS, ed. *Tumours of the hamster.* Lyon, France: International Agency for Research on Cancer; 1982. p. 343–69.
 25. Simmons JH, Riley LK, Franklin CL. Hamster polyomavirus infection in a pet Syrian hamster (*Mesocricetus auratus*). *Vet Pathol.* 2001;38:441–6.
 26. Barthold SW, Griffey SM, Percy DH. *Hamster. Pathology of laboratory rodents and rabbits.* Chichester, UK: John Wiley & Sons, Inc.; 2016. p. 173–98.
 27. Pour P, Mohr U, Althoff J, Knoch N. Spontaneous tumors and common diseases in two colonies of Syrian hamsters. III. Urogenital system and endocrine glands. *J Natl Cancer Inst.* 1976;56:949–61.
 28. Quimby F, Nunez N, Finlay B, Lok B. Adenocarcinoma of the thyroid gland parafollicular C-cells in Djungarian hamsters (*Phodopus sungorus*). *Lab Anim Sci.* 1982;32:413.
 29. Tanaka A, Hisanaga A, Ishinishi N. The frequency of spontaneously occurring neoplasms in the male Syrian golden hamster. *Vet Hum Toxicol.* 1991;33:318–21.
 30. Meredith A, Johnson Delaney C. *Manual of exotic pets.* Gloucester, UK: BSAVA; 2010.
 31. Orr, H. Rodents: neoplastic and endocrine diseases. In: Keeble E, Meredith A, editors. *Manual of rodents and ferrets.* Gloucester, UK: BSAVA; 2018. p. 181–92.
 32. Friedell GH, Oatmann BW, Sherman JD. Report of a spontaneous myxofibrosarcoma of the hamster cheek pouch. *Transplant Bull.* 1960;7:97–100.
 33. Bennett RA. Soft tissue surgery. In: Quesenberry KE, Carpenter JW, editors. *Ferrets, rabbits and rodents – clinical medicine and surgery.* St. Louis, MO: Elsevier; 2012. p. 373–91.
 34. Li X, Wardrip CL, Seps SL, Padrid P. Renal cell carcinoma in two Siberian hamsters (*Phodopus sungorus*). *Top Lab Anim Sci.* 1995;37:70–3.
 35. Fortner JG, George PA, Sternberg SS. Induced and spontaneous thyroid cancer in the Syrian (golden) hamster. *Endocrinology.* 1960;6:364–76.
 36. Bauck L, Orr JP, Lawrence KH. Hyperadrenocorticism in three teddy bear hamsters. *Can Vet J.* 1984;25:247–50.

How to cite this article: Rother N, Bertram CA, Klopfleisch R, et al. Tumours in 177 pet hamsters. *Vet Rec.* 2021;e14.
<https://doi.org/10.1002/vetr.14>