

Tumors of the urinary system in cats

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ABSTRACT

Tumors of the urinary tract of cats are uncommon. Although a few surveys have been performed worldwide, investigation of these tumors in Croatia is lacking. The purpose of this research was to document epidemiological and tumor data from cats with urinary tumors. The study included cats histologically diagnosed with urinary tumors at the Department of Veterinary Pathology from 2009 to 2022. The following data were analyzed: the breed, sex, and age of the cats, tumor location, tumor type, and biological behavior. Tumors affected the urinary system in 34 cats, corresponding to tumor prevalence of 1.06% (general population), and 3.26% (tumor-bearing cats). Non-purebred cats (73.53%) and females (61.77%) were overrepresented. The average age of the affected animals was 9.42 years. The most frequent diagnoses were lymphoma (58.82%) and urothelial carcinoma (17.65%). The affected locations were the kidneys (73.53%) and urinary bladder (26.47%). Most tumors were malignant (97.06%). Where it could be determined, the cause of death was disseminated neoplastic disease with concurrent affection of the urinary system (75%), and primary urinary neoplasia (15%), while in 10% urinary tumors were not associated with the cause of death. This study gives an insight into the urinary tumors that affect Croatian felines. The tumor prevalence and types diagnosed correspond to the literature data, showing that the Croatian population suffers from the same tumors as populations elsewhere. The affected cats were usually of old age, female, and non-purebred, and often had a disseminated neoplastic disease, and grave prognosis. The low prevalence indicates that these tumors are rare, but nevertheless important diseases of the urinary tract in cats.

Key words: feline; urinary system; neoplasia; histology; female; non-purebred

Introduction

Tumors are a major health concern in pets ([DOBSON, 2011](#); [WITHROW et al., 2013](#)). It is estimated that one in four cats will die from tumors or a tumor-related disease ([MORRIS and DOB-](#)

[SON, 2001](#); [DOBSON, 2011](#)). Tumors affecting cats are mostly diagnosed in the skin and subcutis, mammary glands, and the digestive and hemolymphatic systems ([DOBSON, 2011](#); [HUBER et al., 2024](#)). Generally, neoplasms of the urinary system

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are uncommon in cats, comprising < 4% of feline tumors ([VASCELLARI et al., 2009](#); [SHIDA et al., 2010](#); [GRAF et al., 2015](#); [CIANCIOLO and MOHR, 2016](#); [HUBER et al., 2024](#)). A tumor of the urinary tract could involve the kidneys, ureters, urinary bladder, and urethra, but mostly they affect the kidneys and urinary bladder, while other sites are rarely diagnosed with neoplastic growth ([CIANCIOLO and MOHR, 2016](#); [MEUTEN and MEUTEN, 2017](#)). Tumors developing in the urinary system may be primary (when they develop from cells of the urinary tract) or metastatic, being primary elsewhere and spreading by direct extension, or by lymph or blood vessels into the urinary organs ([MEUTEN and MEUTEN, 2017](#)). Metastatic tumors are more frequent in the kidneys, while they are sporadic in other parts of the urinary system ([CIANCIOLO and MOHR, 2016](#); [MEUTEN and MEUTEN, 2017](#)).

Renal tumors are the most common site for urinary tract neoplasia in cats ([MEUTEN and MEUTEN, 2017](#)). The most common renal tumor is lymphoma which is often part of a generalized or multicentric disease ([MEUTEN and MEUTEN, 2017](#); [SULA and LANE, 2022](#)). Tumors of the renal pelvis, ureter, and urethra are rare, and, when present, are usually urothelial carcinomas ([MEUTEN and MEUTEN, 2017](#); [SULA and LANE, 2022](#)). Metastatic tumors in these regions are uncommon ([MEUTEN and MEUTEN, 2017](#)). Tumors of the urinary bladder are uncommon, and in contrast to renal tumors, are mostly primary tumors ([MEUTEN and MEUTEN, 2017](#)). Most primary tumors are urothelial carcinomas, while other types of carcinomas, sarcomas and benign tumors are rarely reported ([MEUTEN and MEUTEN, 2017](#); [SULA and LANE, 2022](#)). More than 90% of urinary bladder tumors are malignant, however, they are usually slow growing and late to metastasize ([CIANCIOLO and MOHR, 2016](#); [MEUTEN and MEUTEN, 2017](#)).

Very few epidemiological studies of urinary tumors in cats have been published. One reason is that most of the reported tumors are presented as case reports, due to the low encounter rate of these tumors ([TAKAGI et al., 2005](#); [IDE et al., 2009](#); [DA SILVA et al., 2019](#); [CATANIA et al., 2023](#)). The reported

prevalence for urinary tract tumors varies from 0.8% to 3.6% for all feline tumors, with no determined breed, age, or sex predisposition ([VASCELLARI et al., 2009](#); [SHIDA et al., 2010](#); [GRAF et al., 2015](#); [HUBER et al., 2024](#)). Most studies focus on clinical research rather than tumor prevalence ([WILSON et al., 2007](#); [HENRY et al., 2016](#)). Some research focuses only on parts of the urinary system, such as the lower urinary tract ([CANNON and ALLSTADT, 2015](#)) or kidneys ([HENRY et al., 2016](#)).

Cats are the second most popular pet species in Croatia. However, tumors affecting the urinary system of the Croatian cat population have not yet been extensively investigated. Considering the limited literature data, the current retrospective, pathological study was performed, with the purpose of documenting the prevalence of spontaneously arising urinary system tumors in cats, over a 14-year period. Further, the aim was to determine the epidemiological data of the affected cats, including breed, age, and sex distribution, as well as pathological data, including tumor type and location, and biological behavior.

Materials and methods

This retrospective study was based on spontaneous tumors of the urinary tract in cats that were diagnosed histologically at the Department of Veterinary Pathology, Faculty of Veterinary Medicine, University of Zagreb. The study included archived diagnostic records and their corresponding histological slides dated from 1st January 2009 to 31st December 2022, originating from cats diagnosed with at least one tumor in the urinary system. Originally, histology slides were generated by two different examination methods: sampling of biopsies, and necropsy upon the owners' request. Cases where no histopathology was performed after necropsy were discarded. For histopathology, tissue was fixed in 10% neutral buffered formalin for 24-48 hours, dehydrated, embedded in paraffin, cut to a thickness of 5 µm, and stained with hematoxylin and eosin (HE). All slides were stored in a dark and dry place protected from dust prior to this study.

The histology slides were reevaluated by light microscopy by eight trained pathologists. In cas-

es when there was no consensus between the pathologists, the diagnosis favored by most pathologists was set. Tumors encountered were classified and labeled according to the current literature and nomenclature ([MEUTEN and MEUTEN, 2017](#)). Animals diagnosed with hyperplastic changes or polyps were excluded. On the basis of the histology findings, the tumors were further classified as benign or malignant. In cats with multiple consecutive samples from the same tumor, the sample was counted and analyzed only once.

From the submission form, data on the breed, sex, and age of cats were obtained. Breed classification was conducted according to the Federation of Felinological Societies of Croatia ([CROATIAN FELINE ASSOCIATION, 2024](#)). Domestic breeds, domestic shorthair cats, domestic longhair, or domestic semi-longhair cats were classified as non-purebred cats. Cats of two breeds (mixed breed) were also classified as non-purebred cats. The data on the location of the tumor were obtained from the submission form in biopsies, or from the necropsy report in the case of necropsies. If the location of the tumor was not noted in the submission form, it was determined during histology when parts of the resident tissue were present.

Statistical analysis was performed using Statistica for Windows, version 14.0.0.15. (Statsoft, Inc., USA). The student's t-test was used to analyze age and Pearson's chi-squared test/ Fisher's exact test were used to determine whether there was a statistically significant difference between malignant tumors in relation to sex (male vs. female) and breed (pure breed vs. not-purebred). A statistically significant difference was determined if $P < 0.05$. No statistical analysis was performed for benign tumors as their number was very low (one case).

Results

In the investigated period, histological samples from 3207 cats were examined at the Department (baseline population). In this population, the non-purebred to pedigree cat ratio was 77.75% : 22.25%, while the male to female ratio was 50.81% : 49.19%. The mean age of the cats was 6.99 years (range 5 days – 22 years).

In 1044 cats at least one tumor was diagnosed by histopathology (tumor-bearing population). The non-purebred to pedigree cat ratio was 69.26% : 30.74%, while the male to female ratio was 43.00% : 57.00%. The mean age of the cats was 10.82 years (range 2 months – 22 years).

Cats diagnosed with urinary tumors. Urinary tumors were diagnosed in 34 cats. The prevalence of urinary tumors corresponded to 1.06% in the baseline population, and 3.26% in the population of tumor-bearing cats. The most frequently affected breed was non-purebred (25 cases, 73.53%), followed by European shorthaired (four cats, 11.76%). Single cats were Bengal (2.94%), British Shorthaired (2.94%), and Persian (2.94%). In two cats the breed was unknown (5.89%). The non-purebred to pedigree ratio was 78.13% : 21.87%. Statistical analysis revealed that non-purebred cats were more affected by urinary tumors than pedigree cats ($\chi^2=7.11$, $P=0.008$). Further, the breed distribution statistically differed from the baseline population ($\chi^2=1971.29$, $P<0.001$) and the population of tumor-bearing cats ($\chi^2=374.58$, $P<0.001$), indicating that non-purebred cats were more represented in the population of cats with urinary tumors.

Most cats were female (21 cats, 61.77%), twelve cats were male (35.29%), and in one cat the sex was unknown (2.94%). The male to female ratio was 36.37% : 63.63%. Statistical analysis failed to prove a sex predisposition for developing urinary tumors ($\chi^2=1.67$, $P=0.197$). The sex distribution differed statistically from the baseline population ($\chi^2=1254.04$, $P<0.001$) and population of tumor-bearing cats ($\chi^2=282.03$; $P<0.001$), indicating that female cats were more represented in the population of cats with urinary tract tumors.

The mean age of the cats affected by urinary neoplasia was 9.42 years (range 1 y. – 18 y., median 9 years; age unknown in one cat). The mean age was statistically higher than the mean age from the baseline population (9.42 ± 5.23 years old vs 6.99 ± 5.17 years old, $P<0.007$). There was no statistical difference in the mean ages of cats with urinary neoplasia and tumor-bearing cats (9.69 ± 5.17 years old vs. 9.42 ± 5.23 years old, $P<0.739$).

In all the cats the urinary tumor affected only

one anatomical location within the urinary system. The most frequent tumor type was lymphoma (Fig. 1), diagnosed in 20 cats (58.82%), followed by urothelial carcinoma (six cats, 17.65%; Fig. 2) (Table 1). Other tumor types were: metastatic carcinoma of the cutaneous apocrine glands (one cat, 2.94%), metastatic lung carcinoma (one cat, 2.94%; Fig. 3A and 3B), histiocytic sarcoma (one cat, 2.94%; Fig. 3C and 3D), myxoma (one cat, 2.94%; Fig. 4), myxosarcoma (2.94%; Fig. 5), renal carcinoma (one cat, 2.94%), round cell neoplasia (one cat, 2.94%), and undifferentiated neoplasia (one cat, 2.94%). The biological behavior of the tumors was malignant in 33 cats (97.06%), while in one cat the tumor was benign (myxoma; 2.94%). Most tumors were diagnosed in the kidney (25 cats, 73.53%; Table 1), while the remaining nine tumors were diagnosed in the urinary bladder (26.47%; Table 1). From the 22 renal tumors in which the primary tumor site could be determined (on the basis

of either the necropsy report or history data from the biopsy submission form), 15 tumors were metastatic in the kidney (68.18%). Of the seven urinary bladder tumors, in which the primary tumor site could be determined, all the tumors were primary bladder tumors (100%).

When considering only the diagnosis of lymphoma (20 diagnoses in total): 19 lymphomas affected the kidney (95.00%), while one lymphoma affected the urinary bladder (5.00%). Of the 19 lymphomas affecting the kidney 12 lymphomas (63.16%) were multicentric also affecting other organs in the body; four lymphomas (21.05%) were primary renal lymphoma; and three lymphomas (15.79%) were submitted as biopsies, with limited history data, hence no conclusion on the affection of other organs could be made. The one lymphoma affecting the urinary bladder (Fig. 6) was also submitted as biopsy, hence no conclusion on the affection of other organs could be made.

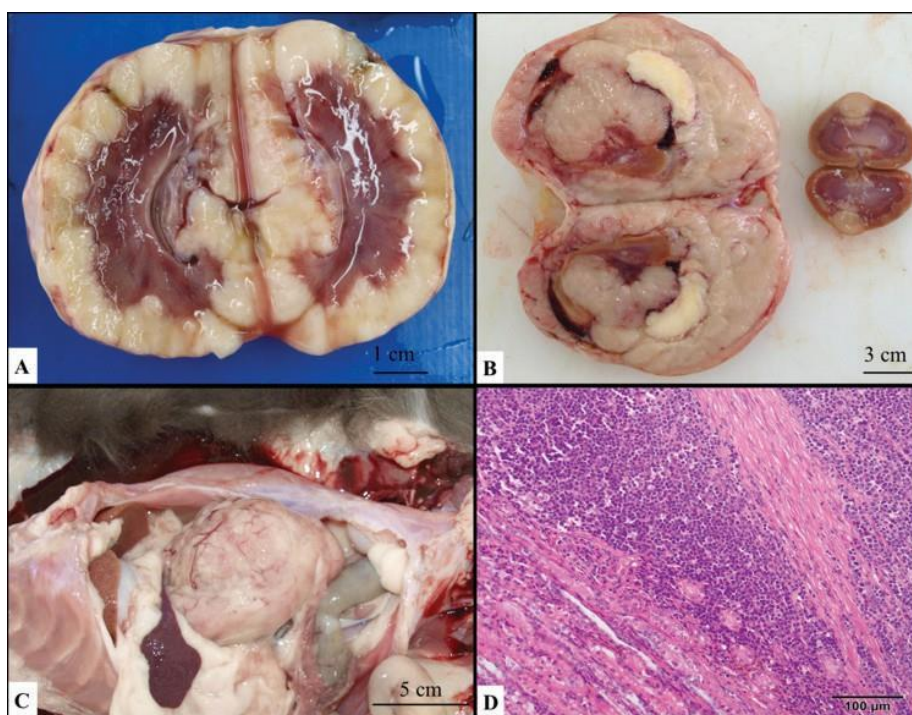


Fig. 1. Renal lymphoma

A: The cortex is diffusely replaced by a white, homogenous, bulging neoplasm infiltrating and compressing the medulla. B: More than 90% of the left kidney tissue is replaced by a white to tan neoplasm. Within the cortex of the right kidney is a single, tan, nodular neoplasm focally compressing and infiltrating the medulla. C: Abdominal cavity, view from ventral side, same case as B. The left kidney is severely enlarged due to neoplastic growth. D: Same case as B – neoplastic lymphocytes are infiltrating the cortex and medulla, hematoxylin and eosin stain (HE), objective magnification, 20x.

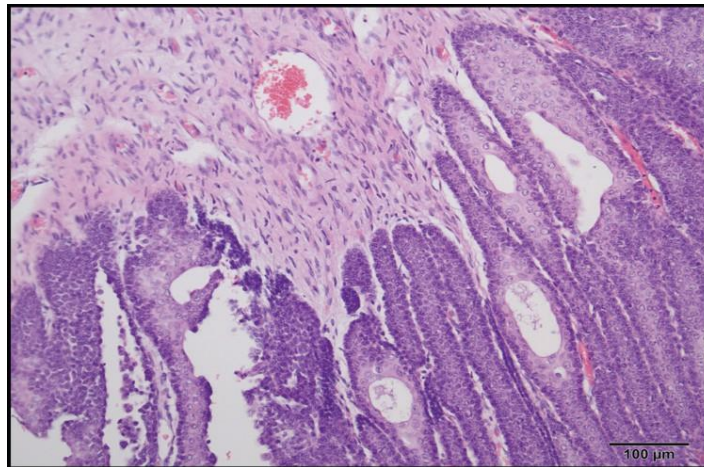


Fig. 2. Urothelial carcinoma of the urinary bladder: neoplastic urothelium forms irregular layers infiltrating the submucosa. HE, 20x

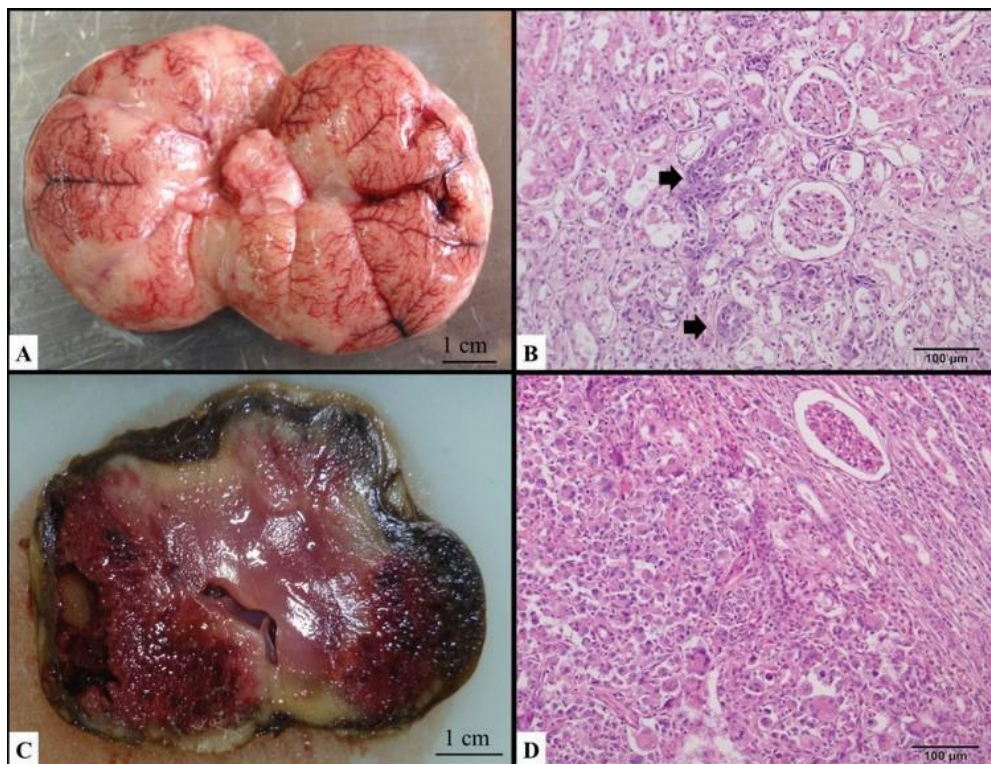


Fig. 3. A. Metastatic lung carcinoma affecting the renal cortex: irregular, multifocal to coalescing, tan areas which are slightly elevated. B. Same case as A: multifocal areas of neoplastic cells forming small anastomosing islands within the renal cortex (arrows), HE, 20x. C: Histiocytic sarcoma of the kidney, on cut section – the cortex is diffusely replaced by irregular, coalescing areas of tan, soft neoplasm compressing the medulla. Within the neoplasm are extensive areas of necrosis and hemorrhage. D: Same case as C: within the cortex is an unencapsulated, infiltrative neoplasm composed of round cells with an oval nucleus and abundant cytoplasm, pronounced pleomorphism and numerous multinucleated cells, corresponding to histiocytic sarcoma. HE, 20x.

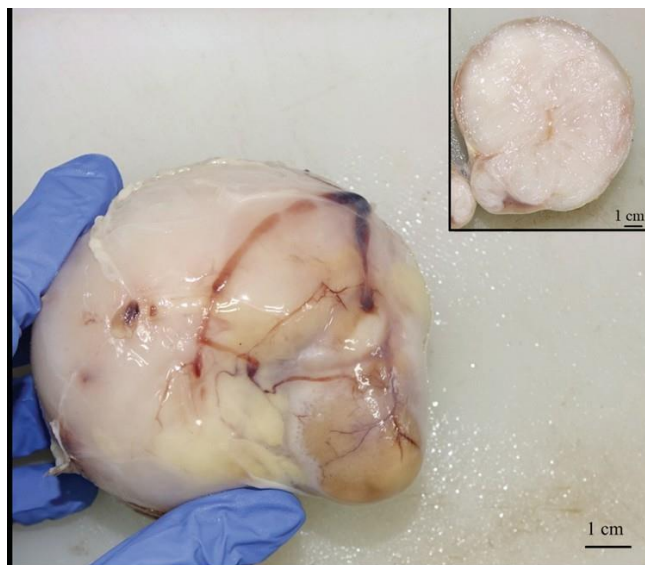


Fig. 4. Myxoma

The kidney is enlarged due to the presence of a firm, white mass. Inset: The cut surface of the neoplasm is mildly wet due to small amount of transparent, mucous fluid.

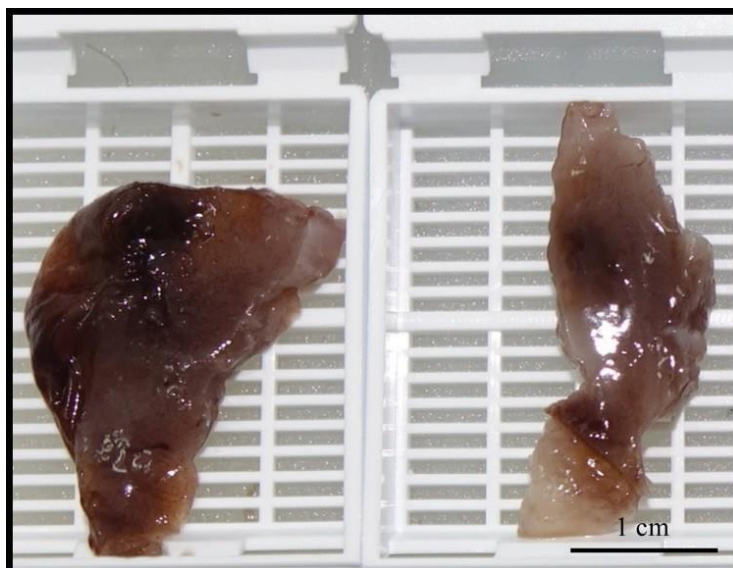


Fig. 5. Myxosarcoma

Serial cuts of a neoplasm growing in the mucosa of the urinary bladder. The cut surface is firm, with abundant transparent, mucous fluid. Prior to cutting, the neoplasm was fixed for 24 h in 10% formalin.

In 14 cats, tumors were diagnosed on the basis of organ biopsy (41.18%), while the remaining 20 tumors were diagnosed at necropsy (58.82%). Of the cats that were necropsied, in 15 cases (75%) the tumor in the urinary system was a consequence of a dissemi-

nated neoplastic disease which caused demise: multicentric lymphoma affecting the kidney (12 cats, 60%), histiocytic sarcoma (one cat, 5%; the sarcoma also affected the lungs and spleen), metastatic apocrine gland carcinoma (one cat, 5%), and metastatic

Table 1. Tumor types diagnosed in the urinary tract - number

Organ	Diagnosis	No. of cases	Percentage (%)
Kidney (25 tumors)	Lymphoma	19	76%
	Histiocytic sarcoma	1	4%
	Metastatic carcinoma of the apocrine glands	1	4%
	Metastatic lung carcinoma	1	4%
	Myxoma	1	4%
	Renal carcinoma	1	4%
	Undifferentiated neoplasia	1	4%
Urinary bladder (9 tumors)	Urothelial carcinoma	6	66.67%
	Lymphoma	1	11.11%
	Myxosarcoma	1	11.11%
	Round cell tumor	1	11.11%

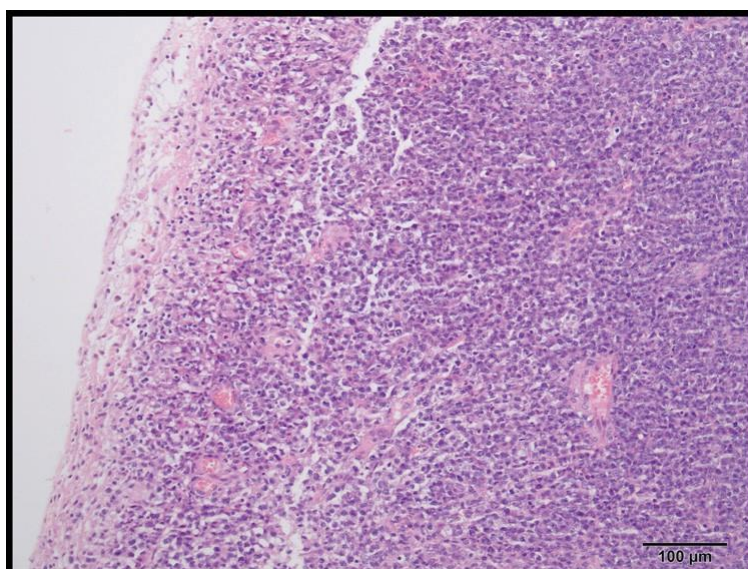


Fig. 6. Lymphoma of the urinary bladder: the mucosa is thickened, with completely disrupted architecture, due to infiltration with neoplastic lymphocytes. HE, 20x

lung carcinoma (one cat, 5%). In the remaining five necropsied cats, urinary neoplasia was the cause of demise in three cats (15%; all diagnosed with renal lymphoma), while in two cats (10%) tumors of the urinary tract were secondary lesions not directly associated with cause of death (renal lymphoma/one cat, 5%; and renal carcinoma/one cat, 5%).

Discussion

Tumors in the urinary system of pets are uncommon. Due to the sparse data for cats, mostly based on case reports ([IDE et al., 2009](#); [KNAPP and MCMILLAN, 2013](#); [DA SILVA et al., 2019](#)), the current study was performed. It included a detailed analysis of epidemiological and pathological data. The study also represents the first Croatian

study focused solely on tumors of the urinary system of cats. Previously, urinary tumors of cats in Croatia have only been mentioned briefly in one study, which described lymphoma and urothelial carcinoma as the most frequent tumors affecting the feline urinary system ([HUBER et al., 2024](#)). This research did not describe any epidemiological or pathological data regarding urinary tumors, but rather focused on all neoplastic diagnosis detected in Croatian cats ([HUBER et al., 2024](#)). The current study presents detailed epidemiological data on urinary tumor-bearing cats, accompanied by statistical analysis, as well as gross and histological photographs of some diagnosed tumors.

In the population of tumor-bearing cats, the prevalence of urinary tract neoplasia was low (3.26%). However, the tumor prevalence reported in this study is higher than previously reported prevalences of 0.8% from Italy, 1.26% from Switzerland, and 1.2% from Japan ([VASCELLARI et al., 2009](#); [SHIDA et al., 2010](#); [GRAF et al., 2015](#)). When compared to a recently published study on feline tumors from Croatia reporting the prevalence of urinary tumors as 3.6%, the prevalence in the current study was slightly lower. The discrepancy is probably the result of differences in breed, age, and sex proportions in the investigated populations ([VASCELLARI et al., 2009](#); [SHIDA et al., 2010](#); [GRAF et al., 2015](#); [HUBER et al., 2024](#)).

The tumor type, frequency, and location within the urinary system in this study were similar to previously reported data ([IDE et al., 2009](#); [SHIDA et al., 2010](#); [KNAPP and MCMILLAN, 2013](#); [HENRY et al., 2016](#); [CIANCIOLO and MOHR, 2016](#); [MEUTEN and MEUTEN, 2017](#); [DA SILVA et al., 2019](#); [SULA and LANE, 2022](#); [CATANIA et al., 2023](#)), implying that cats from Croatia suffer from similar tumors to cats in other parts of the world.

Although urinary tumors are a rare type of neoplasia, when detected, urinary neoplasia is frequently associated with the death of the patient. Namely, in 90% of the investigated cats with urinary neoplasia, where the cause of death could be determined, the neoplasia was the primary cause of death. These findings imply that, if detected, urinary neoplasia mostly implies a grave prognosis.

In 75% of cases, where the cause of death could be determined, the demise was a consequence of the disseminated neoplastic disease, which also affected the urinary system, usually the kidneys. This result suggests that when organs of the urinary system are affected by neoplasia, disseminated disease should be ruled out.

The majority of urinary tumors in our study showed malignant biological behavior, which was also concluded by other studies in the veterinary literature ([KNAPP and MCMILLAN, 2013](#); [GRAF et al., 2015](#); [MEUTEN and MEUTEN, 2017](#); [HUBER et al., 2024](#)). In one study of feline tumor cases from Japan, all the tumors diagnosed in the urinary system showed malignant behavior ([SHIDA et al., 2010](#)). So far, there is no explanation as to why urinary tumors tend to be more malignant, which calls for further research on this topic.

The lack of benign tumors may be explained by the fact that these tumors cause clinical illness less often than malignant tumors. The urinary tract is not a highly accessible tissues for clinical examination as it is a relatively concealed internal organ, therefore it might be hard for owners, but also veterinarians, to suspect urinary disease, especially in cases where no clinical signs are present. This can result in a falsely lower prevalence of benign urinary tumors. We tried to overcome this bias by screening cats on necropsy, where the whole animal was available for examination, but the number of benign urinary tumors was still low, which may imply that these tumors are indeed rare in cats.

No breed predisposition was found for cats affected by urinary tumors. However, statistical analysis showed that non-purebred cats were more frequently affected by a urinary tumor, when compared to the baseline population and tumor-bearing cats. One reason may be that non-purebred cats present the predominant cat breed in Croatia, which is visible in the data from the baseline population. Another reason might be that non-purebred cats show a predisposition for developing urinary tumors, but due to the low number of cases in the current study, we cannot definitively prove our claims. Other research also noted that cats affected with renal and urinary bladder tumors were mostly non-purebred cats ([WILSON et al., 2007](#); [HENRY et al., 2016](#)). Further research in this field is warranted.

Although statistical analysis failed to detect a sex predisposition for urinary tumors, females were more affected by urinary tumors. Furthermore, the male to female ratio was statistically different than the ratio in the baseline population (male cats were predominant) and the population of tumor-bearing cats (female were predominant, but with a higher male to female ratio). So far, no explanation for sex predisposition can be found in the literature, but contrary to our research, others noted a higher number of male cats were diagnosed with renal ([HENRY et al., 2016](#)) and urinary bladder tumors ([PATNAIK et al., 1986](#); [WILSON et al., 2007](#)).

Regarding age, urinary tumors tend to affect older cats, which was also noted in our research. Similar data were also found in other research ([HENRY et al., 2016](#); [CIANCIOLO and MOHR, 2016](#); [MEUTEN and MEUTEN, 2017](#)), where mostly older cats were affected by urinary tumors (the exceptions were rhabdomyosarcomas and lymphoma of the urinary bladder, which were diagnosed in young animals) ([PATNAIK et al., 1986](#); [MEUTEN and MEUTEN, 2017](#)).

In contrast to renal tumors, most tumors of the urinary bladder are primary bladder tumors (100% in the current study). This was also noted in other research from the veterinary literature, where the urinary bladder was rarely affected by metastatic disease ([KNAPP and MCMILLAN, 2013](#); [CIANCIOLO and MOHR, 2016](#); [MEUTEN and MEUTEN, 2017](#); [SULA and LANE, 2022](#)). So far, there is no definite explanation why kidneys tend to develop fewer primary tumors than the urinary bladder. One possible explanation is that secretion of carcinogens through the urine, with simultaneous retention of urine, may cause prolonged contact of carcinogens with bladder mucosa, causing primary neoplastic proliferation ([KNAPP and MCMILLAN, 2013](#); [CIANCIOLO and MOHR, 2016](#); [MEUTEN and MEUTEN, 2017](#); [SULA and LANE, 2022](#)). Another explanation is that the normal anatomy and function of the kidney may result in more frequent metastatic renal tumors than metastatic urinary bladder tumors. Namely, the kidneys possess a dense vascular network, as the normal function of the kidney, among others, is filtration of blood ([SULA and LANE, 2022](#)). Due to the constant con-

tact of the organ with blood, circulating neoplastic cells can frequently encounter renal parenchyma, causing metastases ([SULA and LANE, 2022](#)).

The current study analyzed the epidemiological and pathological data of the cats affected by urinary tumors. The results showed interesting facts, including usually old age, female sex, and non-purebred breed of the tumor-bearing cats. Also, tumor-bearing cats often had disseminated neoplastic disease with a concurrent affection of the urinary tract, and grave prognosis. However, all these results were obtained from a small sample size, although numerous reports were screened for the presence of urinary tumors. Due to the low prevalence, either a larger number of cats should be screened, if available, or the study period should be prolonged. Due to the relatively small number of cats available compared to larger European diagnostic centers, we chose a longer study period of 13 years to increase the number of cases. This may lead to a bias in the data as the situation regarding tumor type may have changed over these 13 years, as the distribution of age, sex and breed changes over time due to longer lifespans and better veterinary care for pets, owner preferences, some breeds going out of fashion, etc. Despite being rare, these tumors are still an important pathology of the urinary tract and must be included in the list of differential diagnoses in feline patients with urinary tract disease.

Conclusions

Urinary tract tumors in cats in Croatia are rare, as they show a low prevalence. The affected cats were usually non-purebred, of old age, and female. The kidneys and urinary bladder were the only anatomic locations where tumors were diagnosed in the investigated cats, and the vast majority of the tumors were malignant. The most frequent tumors were lymphoma and urothelial carcinoma. Cats diagnosed with urinary tumors often had disseminated neoplastic disease with a concurrent affection of the urinary system, and grave prognosis. These results will be helpful and useful in the diagnostic process in feline oncology, and for client information regarding the prevalence and types of tumors

encountered in the urinary tract of feline patients. This will further help clinicians in determining diagnostic procedures, treatment plans, and prognosis.

References

- CANNON, C. M., S. D. ALLSTADT (2015): Lower Urinary Tract Cancer. *Vet. Clin. North. Am. Small. Anim. Pract.* 45, 807-824.
<https://doi.org/10.1016/j.cvsm.2015.02.008>
- CATANIA, E., S. INGRAFFIA, R. FERRIANI, F. TORRIGIANI, E. TREGGIARI (2023): Renal histiocytic sarcoma in a cat undergoing nephrectomy and adjuvant chemotherapy. *Vet. Rec. Case. Rep.* 11, e660.
<https://doi.org/10.1002/vrc2.660>
- CIANCIOLO, R. E., F. C. MOHR (2016): Urinary System. In: Jubb, Kennedy, and Palmer's Pathology of Domestic Animals, Vol. 2. (Maxie, M.G., Ed.), 6th edition, Elsevier, Missouri, USA, pp. 444-464.
- CROATIAN FELINE ASSOCIATION (2024): Categories of cat breeds, Federation of Felinological Societies of Croatia. <https://www.sfdh.hr/en/pasmine-macaka/>, (accessed 18th October 2024). (in Croatian)
- DA SILVA, T. O., F. ZULIANI, N. S. ROCHA, C. E. FONSECA ALVES (2019): Renal Myxoma in a Feline. *Acta. Sci. Vet.* 47, S422.
<https://doi.org/10.22456/1679-9216.95723>
- DOBSON, J. M. (2011): Introduction: cancer in cats and dogs. In: BSAVA Manual of Canine and Feline Oncology. (Dobson, J. M., B. D. X. Lascelles, Eds.), 3rd edition, BSAVA, UK, pp.1-5.
- GRAF, R., K. GRÜNTZIG, M. HÄSSIG, K. W. AXHAUSEN, S. FABRIKANT, M. WELLE, D. MEIER, F. GAUSCETTI, G. FOLKERS, V. OTTO, A. POSPISCHIL (2015): Swiss Feline Cancer Registry: A Retrospective Study of the Occurrence of Tumors in Cats in Switzerland from 1965 to 2008. *J. Comp. Pathol.* 153, 266-277.
<https://doi.org/10.1016/j.jcpa.2015.08.007>
- HENRY, C. J., S. E. TURNQUIST, A. SMITH, J. C. GRAHAM, D. H. THAMM, M. O'BRIEN, C. A. CLIFFORD (2016): Primary renal tumors in cats: 19 cases (1992-1998). *J. Feline Med. Surg.* 1, 165-170.
[https://doi.org/10.1016/S1098-612X\(99\)90205-X](https://doi.org/10.1016/S1098-612X(99)90205-X)
- HUBER, D., K. SEVERIN, D. VLAHOVIĆ, S. KRIŽANAC, S. MOFARDIN, I. MIHOKOVIĆ BUHIN, L. MEDVEN ZAGRADIŠNIK, I.-C. ŠOŠTARIĆ-ZUCKERMANN, A. GUDAN KURILJ, B. ARTUKOVIĆ, M. HOŠTETER (2024): Cancer morbidity in Croatian cats: Retrospective study on spontaneously arising tumors (2009–2019). *Top. Companion Anim. Med.* 58, 100841.
<https://doi.org/10.1016/j.tcam.2023.100841>
- IDE, K., A. SETOBUCHI-MUKAI, T. NAKAGAWA, K. UETSUKA, H. NAKAYAMA, Y. FUJINO, K. OHNO, H. TSUJIMOTO (2009): Disseminated Histiocytic Sarcoma with Excessive Hemophagocytosis in a Cat. *J. Vet. Med. Sci.* 71, 817-820.
<https://doi.org/10.1292/jvms.71.817>
- KNAPP, D. W., S. K. MCMILLAN (2013): Tumors of the Urinary System. In: Withrow & MacEwen's Small Animal Clinical Oncology. (Withrow, S. J., D. M. Vail, R. L. Page, Eds.), 5th edition, Elsevier Saunders, St. Louis, Missouri, USA, pp. 572-580.
- MEUTEN, D. J., T. L. K. MEUTEN (2017): Tumors of the Urinary System. In: Tumors in Domestic Animals. (Meuten, D. J., Ed.), 5th edition, Wiley Blackwell, Iowa, USA, pp. 632-688.
- MORRIS, J., J. DOBSON (2001): Introduction. In: Small Animal Oncology. (Morris, J., J. Dobson, Eds.), Blackwell Science, Oxford, UK, pp. 1-3.
- PATNAIK, A. K., P. D. SCHWARZ, R. W. GREENE (1986): A histopathologic study of twenty urinary bladder neoplasms in the cat. *J. Small. Anim. Pract.* 27, 433-445.
<https://doi.org/10.1111/j.1748-5827.1986.tb03961.x>
- SHIDA, T. T. YAMADA, T. MARUO, T. ISHIDA, H. KAWAMURA, H. TAKEDA, H. SUGIYAMA, T. ISHIKAWA, T. ITO, H. MADARAME, H. KAYANUMA, T. SUGANUMA (2010): A Retrospective Study in 1070 Feline Tumor Cases of Japan. *J. Jpn. Vet. Cancer Soc.* 1, 1-7.
<https://doi.org/10.12951/jvcs.1.1>
- SULA, M.-J., L. V. LANE (2022): The Urinary System. In: Pathologic Basis of Veterinary Disease. (Zachary, J. F., Ed.), 7th edition, Elsevier, Missouri, USA, pp. 699-766.
- TAKAGI, S., T. KADOSAWA, T. ISHIGURO, T. OHSAKI, M. OKUMURA, T. FUJINAGA (2005): Urethral transitional cell carcinoma in a cat. *J. Small. Anim. Pract.* 46, 504-506.
<https://doi.org/10.1111/j.1748-5827.2005.tb00280.x>
- VASCELLARI, M., E. BAIONI, G. RU, A. CARMINATO, F. MUTINELLI (2009): Animal tumour registry of two provinces in northern Italy: incidence of spontaneous tumours in dogs and cats. *BMC. Vet. Res.* 5, 39.
<https://doi.org/10.1186/1746-6148-5-39>
- WILSON, H. M., R. CHUN, V. S. LARSON, I. D. KURZMAN, D. N. VAIL (2007): Clinical signs, treatments, and outcome in cats with transitional cell carcinoma of the urinary bladder: 20 cases (1990-2004). *J. Am. Vet. Med. Assoc.* 231, 101-106.
<https://doi.org/10.2460/javma.231.1.101>
- WITHROW, S. J., D. M. VAIL, R. L. PAGE (2013): Why Worry About Cancer in Companion Animals? In: Withrow and MacEwen's Small Animal Clinical Oncology. (Withrow, S. J., D. M. Vail, R. L. Page, Eds.), 5th edition, Elsevier Saunders, Missouri, USA, pp. XV-XVI.

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HUBER, D., D. VLAHOVIĆ, I. MIHOKOVIĆ BUHIN, I. CIPRIĆ, B. ARTUKOVIĆ, A. GUDAN KURILJ, M. HOHŠTETER, K. SEVERIN, I.-C. ŠOŠTARIĆ-ZUCKERMANN, L. MEDVEN ZAGRADIŠNIK: Tumori mokraćnog sustava u mačaka. Vet. arhiv 96, 175-185, 2026.

SAŽETAK

Tumori mokraćnog sustava rijetki su u mačaka. Dok je u svijetu u ovom području provedeno nekoliko istraživanja, u Hrvatskoj ne postoji sustavno istraživanje ovih tumora. Svrha ovog istraživanja bila je dokumentirati epidemiološke podatke i podatke o tumorima mokraćnog sustava u mačaka. U istraživanje su uključene mačke kojima je u Zavodu za veterinarsku patologiju, tijekom razdoblja od 2009. do 2022. godine, dijagnosticiran tumor mokraćnog sustava. Analizirani su sljedeći podaci: pasmina, spol i dob životinje, smještaj tumora, tip tumora te biološko ponašanje tumora. Od tumora mokraćnog sustava oboljele su 34 mačke, što odgovara prevalenciji tumora od 1,06% (opća populacija) odnosno 3,26% (populacija mačaka oboljelih od tumora). Mačke križanih pasmina (73,53%) i ženskog spola (61,77%) bile su češće zahvaćene. Prosječna je dob bila 9,42 godine. Najčešće dijagnoze bile su limfom (58,82%) i urotelni karcinom (17,65%). Zahvaćena mjesta bila su bubrezi (73,53%) i mokraćni mjehur (26,47%). Većina tumora bila je maligna (97,06%). Kada je to bilo moguće utvrditi, uzrok uginuća bio je diseminirana neoplastična bolest s istodobnim zahvaćanjem mokraćnog sustava (75%) ili primarna neoplazija mokraćnog sustava (15%), dok u 10% životinja tumori mokraćnog sustava nisu bili povezani s uzrokom smrti. Ovo istraživanje daje uvid u tumore mokraćnog sustava koji zahvaćaju hrvatsku populaciju mačaka. Prevalencija i tipovi tumora odgovaraju podacima iz literaure i pokazuju da hrvatska populacija mačaka boluje od istih tumora kao i populacije u drugim dijelovima svijeta. Oboljele mačke obično su bile starije životne dobi, ženskog spola, pasmine koja nije čistokrvna te s diseminiranom neoplastičnom bolesti i lošom prognozom. Niska prevalencija pokazuje da su ovi tumori rijetke, ali ipak važne bolesti mokraćnog sustava u mačaka.

Ključne riječi: mačka; mokraćni sustav; neoplazija; histologija; ženke; križane pasmine
