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Renal Cell Carcinoma in a Common Marmoset: First Report and a Brief Review of Nonhuman Primate Literature

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Abstract

Renal cell carcinoma (RCC) is a malignant form of urogenital cancer that arises from renal tubular epithelial cells. Here, we describe a case of renal cell carcinoma in a common marmoset (*Callithrix jacchus*). Immunohistochemistry demonstrated positive reactivity for PAX8 and CD10 in the renal neoplasm; We review 115 cases of spontaneous renal tumors in nonhuman primates (NHP) reported in the literature and from the Southwest National Primate Research Center records. Across all NHPs, malignant renal neoplasms were more frequent than benign. There appears to be a male sex predilection for renal tumors in baboons. This is the first reported case of renal cell carcinoma in a marmoset.

Keywords

neoplasm; tumor; kidney; non-human primate; marmoset

Introduction

Renal cell carcinoma (RCC), arising from renal tubular epithelial cells, is one of the most malignant forms of urogenital cancer and the sixth most common form of cancer in human males [1]. RCC is usually asymptomatic; hematuria, flank pain, and a palpable abdominal mass are seen infrequently [1, 2]. In 20–30% of RCC human patients, the cancer metastasizes most often to the brain, bones, and lungs [2]. RCC is common in humans and is reported in several nonhuman primates (NHP), but has not been reported in marmosets.

Case Report

A seven-year old, female common marmoset (*Callithrix jacchus*) was humanely euthanized for chronic anemia and a very low hematocrit (patient: 12.6%, Reference range: 37–

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53%). A complete necropsy was performed and appropriate tissue samples were taken for histologic evaluation. All tissues were fixed in 10% neutral buffered formalin, processed conventionally, embedded in paraffin, cut at 5 micrometers, stained with hematoxylin and eosin and evaluated by board-certified veterinary pathologists. All animal care and procedures were approved by the Texas Biomedical Research Institute Institutional Animal Care and Use Committee. The lifetime records for the animal were retrieved and reviewed for clinical history and research-use.

At necropsy, the kidneys were bilaterally enlarged, firm, irregularly shaped, and pale to yellow-red. Histologically, bilaterally, the renal cortex was replaced by extensive areas of interstitial fibrosis, degeneration and regeneration of tubular epithelium, ectasia and loss of tubules, glomerular sclerosis, and infiltrates of lymphocytes, plasma cells, and erythroid and myeloid precursors, and megakaryocytes (chronic renal disease and extramedullary hematopoiesis) (Figure 1A, 1B). Additionally, there were two, well demarcated, masses in one kidney. The larger mass contained a central cavitated area filled with hemorrhage, cell debris, and macrophages (Figure 1C, 1D). The smaller mass contained scattered cholesterol clefts (Figure 1E, 1F). Both masses were composed of clusters and rare tubules of polygonal cells supported by a fine fibrovascular stroma (Figure 1D, 1F). The neoplastic cells had distinct cell borders, abundant pale, eosinophilic granular to vacuolated cytoplasm and irregular nuclei with lightly stippled chromatin and 1–2 basophilic nucleoli (Figure 1D, 1F). There were scattered multinucleate cells. Mitoses averaged 1 per 10 HPF. The neoplastic cells in the smaller mass were more pleomorphic (Figure 1F). Immunohistochemistry with markers PAX8, and CD10 was performed. The neoplastic cells of the kidney showed strong positive immunoreactivity to CD10 (Mouse anti-human, Monoclonal antibody, Ventana Cat # 760–2531), (Figure 1G) and PAX8 (Rabbit anti-human, Monoclonal antibody, Ventana, Cat # 790–4341) (Figure 1H),

Materials and Methods

A literature search for all published cases of spontaneous NHP renal tumors was performed. Cases of experimentally induced renal tumors were excluded. Where discrepancies were seen between reports, the data from the original publication of the case was utilized.

Pathology records were reviewed for 26,937 (13,549 female, 12,340 males, 1,048 unknown) NHP necropsied over a 41-year period (1983–2024) at the Southwest National Primate Research Center at the Texas Biomedical Research Institute. Cases from animals in a research study were excluded. Fifteen cases (8 female, 7 male) of renal tumors were identified and the original medical records, gross necropsy, and histopathology reports were reviewed. For each NHP, the following information was obtained: species, age, sex, and tumor type. Four of the 15 had been previously reported (two nephroblastomas, one metastatic adrenal carcinoma, and one metastatic hepatocellular carcinoma) [3–5].

Literature review on renal tumors in NHPs.

Table 1 lists all 115 renal tumors in 114 NHPs, 104 reported in the published literature and 11 identified in the SNPRC pathology database. Cases were arranged by species

including detailed case information, such as age, sex, and tumor type. Aging classification in macaques and baboons were determined according to published age classification [6]. One NHP had two tumors, a papillary renal adenoma and a transitional cell carcinoma.

Primary malignant renal neoplasms ($n = 68$, 64.8%) were more common than benign tumors ($n = 37$, 35.2%) in NHPs and were found to be more common in older animals (total=105); two tumors were of unspecified type. There were eight cases of secondary neoplasms (metastatic to the kidney). Overall, the most frequent tumors (total= 115) were carcinomas ($n = 54$, 47.0%), adenomas ($n = 33$, 28.7%), nephroblastomas ($n = 9$, 7.8%) and lymphomas ($n = 6$, 5.2%). The most common carcinomas were undifferentiated renal carcinomas ($n = 20$), papillary renal carcinomas ($n = 13$), renal adenocarcinomas ($n = 6$), and renal tubulopapillary carcinomas ($n = 5$). The most common adenomas were undifferentiated renal adenomas ($n = 18$) and renal tubular adenomas ($n = 6$). One of the nephroblastomas was a cystic variant. Five of the six lymphomas were multicentric, precluding determination of the tissue of origin.

Metastasis of primary renal neoplasia was uncommon, reported in 11.9% (8 of the 67 malignant neoplasms). Secondary renal neoplasia (metastatic neoplasms to the kidney) included hepatocellular carcinoma, and adrenal carcinoma, and likely lymphoma.

The most frequent NHPs reported with renal tumors in decreasing order were: macaques ($n = 51$), baboons ($n = 26$), prosimians ($n = 16$), marmosets ($n = 6$), and chimpanzees ($n = 3$).

In macaques (*Macaca* spp.), cases of renal carcinomas ($n = 10$), papillary renal carcinomas ($n = 8$), and renal tubular adenomas ($n = 6$) were most commonly reported. The average age overall was 14.33 years. Adult ($n = 25$) and geriatric ($n = 20$) macaques were affected most.

Baboons (*Papio* spp.) were the only species demonstrating a sex bias, with males ($n = 14$) more often affected than females ($n = 6$). Baboons were also unique in that they had more renal adenomas ($n = 11$) than carcinomas ($n = 5$); however, they had the highest rate of nephroblastoma ($n = 4$). The most common renal tumors reported in baboons included renal adenomas ($n = 9$), nephroblastomas ($n = 4$), and lymphomas ($n = 2$). Fourteen baboons (53.85%) were over the age of fifteen and the overall age of incidence in baboons was 16.51 years. Geriatric ($n = 12$) baboons were most affected.

Prosimians (*Cheirogaleus* spp., *Eulemur* spp., *Lemur* spp., *Loris* spp., *Microcebus* spp., *Mirza* spp., *Nycticebus* spp., and *Perodicticus* spp.) were most commonly reported with carcinomas including renal adenocarcinomas ($n = 4$) and renal carcinomas ($n = 3$). Marmosets (*Callithrix* spp.) had a variety of renal tumors, with no predominance of any specific tumor. Chimpanzees (*Pan* spp.) only had reported cases of renal carcinomas ($n = 3$).

Discussion

The marmoset's presentation for anemia was likely due to the kidney's reduced function and ability to produce erythropoietin secondary to the chronic nephritis. The RCC was an incidental finding.

Although different subtypes of primary renal neoplasms are not clearly identified in NHP, in humans, they can be classified histologically into many types. The most common types of RCC are clear cell, papillary, chromophobe, and collecting-duct RCC [2]. Features of clear cell RCC include a low nuclear to cytoplasmic ratio, high vascularity, centrally or eccentrically-placed nuclei, prominent nucleoli, high pleomorphism, and wispy, granular, or vacuolated cytoplasm [7]. Features of papillary RCC include papillary or tubulopapillary growth patterns, long, branching papillae, and surrounding tumor cells arranged in tight clusters/spherules [7]. Papillary RCC are often multifocal and commonly seen in cases of chronic renal disease [8]. Both clear cell and papillary RCC often contain hemorrhage, necrosis, or cystic degeneration [8]. In chromophobe RCC, tumor cells are typically single or in loosely-cohesive groups. The cells have central nuclei with dark chromatin and abundant cytoplasm. Binucleation and nuclear pleomorphism can also be consistent with chromophobe RCC [7]. Collecting-duct RCC is a rare type of renal cell carcinoma arising from collecting ducts in the renal medulla. In 80% of collecting-duct RCC cases, there is metastasis to lymph nodes [7]. Although the presence of multifocal masses in a chronically diseased kidney can be features of papillary RCC, the absence of papillary structures and the cytomorphology of the tumor cells in this case are most consistent with a clear cell RCC.

CD10 (also known as neprilysin) is a membrane-bound zinc-dependent metalloprotease that is highly expressed in renal tissue. It is notably useful in distinguishing between different subtypes of renal cell carcinoma (RCC). It is expressed in clear cell RCC and certain other renal tumors but is absent or weak in other RCC subtypes, such as papillary RCC or chromophobe RCC. In addition, CD10 is useful in identifying renal oncocytoma, a benign tumor, and is also seen in collecting duct carcinomas. Higher CD10 expression in certain tumors may correlate with a more aggressive phenotype and worse prognosis, particularly in clear cell RCC. Pax8 (Paired box gene 8) Pax8 is a transcription factor that is expressed in the epithelial cells of the kidney and is a key marker for renal differentiation. Pax8 is highly sensitive and specific for renal tumors, including RCC and renal oncocytoma. It is also expressed in tumors that arise from the renal collecting ducts. [9–12]

Across all NHPs, malignant renal neoplasms were more frequent than benign; however, this may represent a reporting bias. There appears to be a sex predilection for renal tumors in baboons, with an increased incidence in males.

In conclusion, this is the first report of a renal cell carcinoma in the common marmoset (*Callithrix jacchus*). Although neoplasia is uncommon in marmosets, they have several naturally occurring cancers [13].

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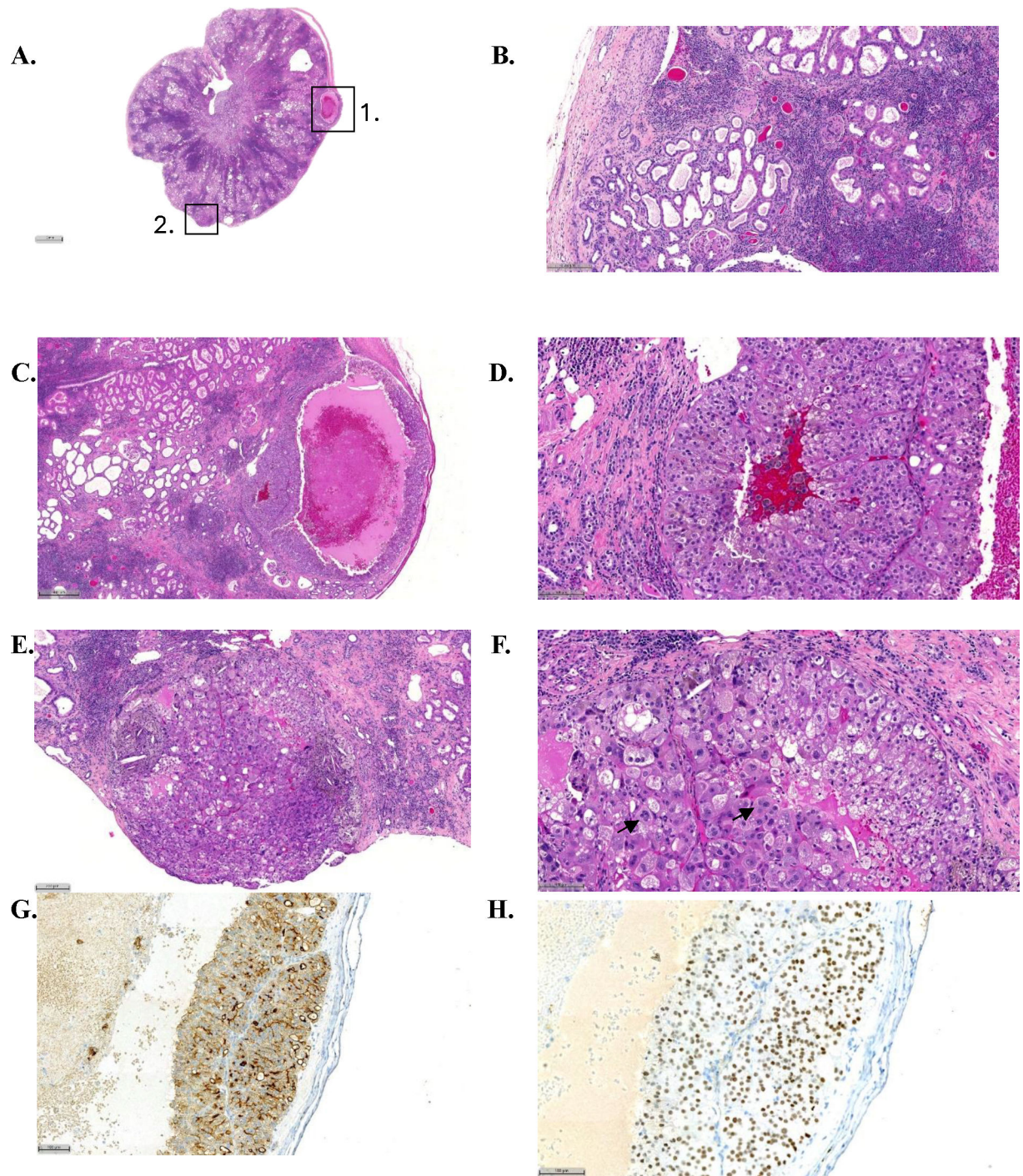


Figure 1.

Histologic evaluation of the kidney. **A:** Subgross image. Note the irregular surface, cellular infiltrates and two well-demarcated masses. **B:** Higher magnification of the cortex showing interstitial fibrosis, degeneration and regeneration of tubular epithelium, ectasia and loss of tubules, glomerular sclerosis, and infiltrates of lymphocytes, plasma cells, and erythroid and myeloid precursors, and megakaryocytes (extramedullary hematopoiesis). **C.** and **D.** Higher magnification of Box 1. Larger, well-demarcated, expansile mass containing

central cavitated area with hemorrhage, cell debris, and macrophages. **E. and F.** Higher magnification of Box 2. Smaller well-demarcated, expansile mass containing cholesterol clefts. Mass is composed of clusters, and rare tubules of polygonal cells supported by a fine fibrovascular stroma. Neoplastic cells have distinct cell borders, abundant pale, eosinophilic granular to vacuolated cytoplasm and irregular nuclei with lightly stippled chromatin and 1–2 basophilic nuclei. Note rare multinucleate cells (arrow marks). **G:** Neoplastic cells exhibiting strong cytoplasmic immunoreactivity to CD10. **H:** Neoplastic cells exhibiting strong nuclear immunoreactivity to PAX8.

Table 1.
Renal Neoplasms in Nonhuman Primates

Genus	Species	Common name	Neoplasm	Age	Sex*	Metastasis	Ref.	Notes
<i>Alouatta</i>	<i>Alouatta caraya</i>	Black howler monkey	Renal adenoma	Adult	Female	No	[14]	
<i>Ateles</i>	<i>Ateles geoffroyi</i>	Black-handed spider monkey	Papillary renal cystadenoma	>5 years	Male	No	[14]	
<i>Cacajao</i>	<i>Cacajao spp.</i>	Uakari	Renal adenosarcoma	Unk	Unk	No	[14]	
<i>Cebus</i>	<i>Cebus apella</i>	Tufted capuchin	Renal carcinoma	Unk	Unk	Yes	[14]	Site of metastasis not specified
<i>Mandrillus</i>	<i>Mandrillus sphinx</i>	Mandrill	Papillary renal carcinoma	>12 years	Female	No	[14]	
<i>Aotus</i>	<i>Aotus trivirgatus</i>	Northern owl monkey	Papillary renal carcinoma	Adult	Male	No	[15]	
<i>Aotus</i>	<i>Aotus trivirgatus</i>	Northern owl monkey	Papillary renal carcinoma	5 years	Female	No	[14]	
<i>Callithrix</i>	<i>Callithrix jacchus</i>	Common marmoset	Renal carcinoma	7 years	Female	No	SNPRC	Present case
<i>Callithrix</i>	<i>Callithrix jacchus</i>	Common marmoset	Renal oncocytoma	4 years	Male	No	SNPRC	
<i>Callithrix</i>	<i>Callithrix jacchus</i>	Common marmoset	Renal adenoma	13 years	Female	No	SNPRC	
<i>Callithrix</i>	<i>Callithrix jacchus</i>	Common marmoset	Renal lymphoma	10 years	Female	Secondary	[3]	Multicentric*
<i>Callithrix</i>	<i>Callithrix jacchus</i>	Common marmoset	Nephroblastoma (cystic variant)	17 months	Male	No	[16]	
<i>Callithrix</i>	<i>Callithrix penicillata</i>	Black-tufted marmoset	Nephroblastoma	Juvenile	Female	Yes	[17]	Site of metastasis not specified
<i>Cercopithecus</i>	<i>Cercopithecus aethiops</i>	Grivet	Renal adenoma	22 years	Female	No	SNPRC	
<i>Cercopithecus</i>	<i>Cercopithecus nigroviridis</i>	Allen's swamp monkey	Papillary renal carcinoma	17 years	Male	No	[14]	
<i>Cheirogaleus</i>	<i>Cheirogaleus medius</i>	Fat-tailed dwarf lemur	Renal adenoma	14 years	Male	No	[18, 19]	
<i>Cheirogaleus</i>	<i>Cheirogaleus medius</i>	Fat-tailed dwarf lemur	Renal adenocarcinoma	19 years	Female	No	[18, 19]	
<i>Eulemur</i>	<i>Eulemur coronatus</i>	Crowned lemur	Renal tubular adenocarcinoma	17 years	Male	No	[18, 19]	
<i>Eulemur</i>	<i>Eulemur coronatus</i>	Crowned lemur	Renal carcinoma	14 years	Female	Yes	[18]	Metastasis to lymph node
<i>Lemur</i>	<i>Lemur catta</i>	Ring-tailed lemur	Mixed renal epithelial & stromal tumor	14.5 years	Female	No	[18, 20]	
<i>Lemur</i>	<i>Lemur catta</i>	Ring-tailed lemur	Adenoleimyofibromatous hamartoma	>11 years	Female	No	[18]	Non-cancerous
<i>Lemur</i>	<i>Lemur spp.</i>	Lemur spp.	Renal adenoma	Unk	Unk	No	[18]	
<i>Lemur</i>	<i>Lemur spp.</i>	Lemur spp.	Mixed renal sarcoma	Unk	Unk	No	[18]	
<i>Lemur</i>	<i>Lemur spp.</i>	Lemur spp.	Adenocarcinoma	Unk	Unk	No	[14]	

Genus	Species	Common name	Neoplasm	Age	Sex*	Metastasis	Ref.	Notes
<i>Loris</i>	<i>Loris tardigradus</i>	Red slender loris	Renal carcinoma	14 years	Male	No	[18, 21]	
<i>Microcebus</i>	<i>Microcebus murinus</i>	Gray mouse lemur	Renal carcinoma	12 years	Male	No	[18]	
<i>Mirza</i>	<i>Mirza coquereli</i>	Coquerel's giant mouse lemur	Renal adenoma	12 years	Female	No	[18, 19]	
<i>Mirza</i>	<i>Mirza coquereli</i>	Coquerel's giant mouse lemur	Renal adenoma	13 years	Male	No	[18, 19]	
<i>Nycticebus</i>	<i>Nycticebus coucang</i>	Sunda slow loris	Renal adenocarcinoma	Unk	Unk	No	[19, 21]	
<i>Nycticebus</i>	<i>Nycticebus pygmaeus</i>	Pygmy slow loris	Renal spindle cell sarcoma	14 years	Male	No	[19, 21]	
<i>Perodicticus</i>	<i>Perodicticus potto</i>	West African potto	Renal adenocarcinoma	Unk	Unk	No	[19, 21]	
<i>Macaca</i>	<i>Macaca fascicularis</i>	Cynomolgus macaque	Renal papillary cyst adenocarcinoma	6 years	Male	No	[14, 22]	
<i>Macaca</i>	<i>Macaca fascicularis</i>	Cynomolgus macaque	Nephroblastoma	3 years	Unk	No	[23]	
<i>Macaca</i>	<i>Macaca fascicularis</i>	Cynomolgus macaque	Nephroblastoma	4.5 months	Female	Yes	[24]	Pulmonary metastasis
<i>Macaca</i>	<i>Macaca fascicularis</i>	Cynomolgus macaque	Renal carcinoma	5 years	Female	No	[25]	
<i>Macaca</i>	<i>Macaca fascicularis</i>	Cynomolgus macaque	Renal lymphoma	Juvenile	Male	Secondary	[26]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal adenoma	22 years	Female	No	[4]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal lymphoma	17 years	Male	Secondary	SNPRC	Multicentric *
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal carcinoma	>20 years	Unk	No	[27]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal carcinoma	>20 years	Unk	No	[27]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal carcinoma	>20 years	Unk	No	[27]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal carcinoma	>20 years	Unk	Yes	[27]	Metastasis to peritoneum and pelvic cavity
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal tubular adenoma	>20 years	Unk	No	[27]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal tubular adenoma	>20 years	Unk	No	[27]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal tubular adenoma	>20 years	Unk	No	[27]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal sarcoma	18 years	Male	Yes	[28]	Site of metastasis not specified
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal tubulopapillary carcinoma	23 years	Male	No	[29]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal tubulopapillary carcinoma	16 years	Female	No	[29]	

Genus	Species	Common name	Neoplasm	Age	Sex*	Metastasis	Ref.	Notes
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal tubulopapillary carcinoma	10 years	Male	No	[29]	Site of metastasis not specified
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal tubulopapillary carcinoma	10 years	Male	Yes	[29]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Papillary renal carcinoma	22 years	Male	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Papillary renal carcinoma	Adult	Female	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Papillary renal carcinoma	>15 years	Male	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal tubular adenoma	18 years	Female	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal tubular adenoma	Adult	Male	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Transitional cell papillomatous hyperplasia and metaplasia	22 years	Female	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Papillary renal carcinoma	16 years	Female	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Papillary renal carcinoma	1 year	Male	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Papillary renal carcinoma	13 years	Male	No	[14, 30]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Papillary renal carcinoma	15 years	Male	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Papillary renal carcinoma	Adult	Female	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal tubular carcinoma	21 years	Male	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal tubular carcinoma	5 years	Male	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal carcinoma	16 years	Female	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal adenocarcinoma	Unk	Male	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal adenocarcinoma	27 years	Male	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Papillary renal adenoma	Adult	Male	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Papillary renal adenoma & transitional cell carcinoma	11 years	Male	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Renal adenoma	9 years	Female	No	[14]	
<i>Macaca</i>	<i>Macaca mulatta</i>	Rhesus macaque	Papillary renal adenoma	8 years	Female	No	[14]	
<i>Macaca</i>	<i>Macaca nemestrina</i>	Pig-tailed macaque	Renal carcinoma	15 years	Male	No	[30]	
<i>Macaca</i>	<i>Macaca nemestrina</i>	Pig-tailed macaque	Papillary renal carcinoma	20 years	Male	No	[14]	
<i>Macaca</i>	<i>Macaca nemestrina</i>	Pig-tailed macaque	Renal carcinoma	Adult	Female	No	[14]	

Genus	Species	Common name	Neoplasm	Age	Sex*	Metastasis	Ref.	Notes
<i>Macaca</i>	<i>Macaca nemestrina</i>	Pig-tailed macaque	Renal tubular adenoma	Adult	Female	No	[14]	
<i>Macaca</i>	<i>Macaca niger</i>	Celebes crested macaque	Renal tubulopapillary carcinoma	>17 years	Male	No	[14]	
<i>Macaca</i>	<i>Macaca niger</i>	Celebes crested macaque	Renal tubular carcinoma	18 years	Female	No	[14]	
<i>Macaca</i>	<i>Macaca spp.</i>	Macaca spp.	Renal papillary adenoma	6 years	Unk	No	[4]	
<i>Macaca</i>	<i>Macaca spp.</i>	Macaca spp.	Renal tubulopapillary adenoma	8 years	Unk	No	[4]	
<i>Macaca</i>	<i>Macaca spp.</i>	Macaca spp.	Renal carcinoma	31 years	Unk	No	[4]	
<i>Macaca</i>	<i>Macaca spp.</i>	Macaca spp.	Renal carcinoma	35 years	Unk	No	[4]	
<i>Macaca</i>	<i>Macaca spp.</i>	Macaca spp.	Hepatocellular carcinoma	3 years	Unk	Secondary	[4]	Metastatic from liver
<i>Macaca</i>	<i>Macaca spp.</i>	Macaca spp.	Adrenal carcinoma	17 years	Unk	Secondary	[4]	Metastatic from adrenal gland
<i>Pan</i>	<i>Pan spp.</i>	Chimpanzee	Renal carcinoma	17 years	Female	No	[31, 32]	
<i>Pan</i>	<i>Pan troglodytes</i>	Chimpanzee	Renal carcinoma	41 years	Unk	No	[4]	
<i>Pan</i>	<i>Pan troglodytes</i>	Chimpanzee	Renal carcinoma	42 years	Unk	No	[4]	
<i>Papio</i>	<i>Papio anubis</i>	Baboon	Renal tubular carcinoma	4 years	Male	No	[33]	
<i>Papio</i>	<i>Papio anubis</i>	Baboon	Reticulosarcoma	20 years	Female	No	[34]	
<i>Papio</i>	<i>Papio cynocephalus</i>	Baboon	Renal tubular adenocarcinoma	18 years	Male	No	[34]	
<i>Papio</i>	<i>Papio cynocephalus anubis</i>	Baboon	Nephroblastoma	6 months	Male	No	[5]	
<i>Papio</i>	<i>Papio cynocephalus anubis</i>	Baboon	Nephroblastoma	2 months	Male	No	[5]	
<i>Papio</i>	<i>Papio cynocephalus anubis</i>	Baboon	Renal medulla papillary carcinoma	28 years	Female	No	[35]	
<i>Papio</i>	<i>Papio cynocephalus anubis</i>	Baboon	Renal medullary adenoma	17 years	Female	No	[35]	
<i>Papio</i>	<i>Papio cynocephalus anubis</i>	Baboon	Nephroblastoma	4 months	Male	No	[35]	
<i>Papio</i>	<i>Papio paio</i>	Baboon	Undifferentiated renal carcinoma	Unk	Male	No	[14]	
<i>Papio</i>	<i>Papio papio</i>	Baboon	Renal adenoma	>15.3 years	Male	No	[34]	
<i>Papio</i>	<i>Papio papio</i>	Baboon	Renal adenoma	15 years	Male	No	[34]	
<i>Papio</i>	<i>Papio papio</i>	Baboon	Renal carcinoma	23 years	Male	No	[34]	
<i>Papio</i>	<i>Papio papio</i>	Baboon	Not Specified	Unk	Male	No	[34]	
<i>Papio</i>	<i>Papio papio</i>	Baboon	Not Specified	4 years	Unk	No	[34]	
<i>Papio</i>	<i>Papio papio</i>	Baboon	Renal adenoma	15 years	Male	No	[14]	

Genus	Species	Common name	Neoplasm	Age	Sex*	Metastasis	Ref.	Notes
<i>Papio</i>	<i>Papio spp.</i>	Baboon	Nephroblastoma	9 months	Female	No	SNPRC	
<i>Papio</i>	<i>Papio spp.</i>	Baboon	Renal lymphoma	16 years	Male	Secondary	SNPRC	Multicentric *
<i>Papio</i>	<i>Papio spp.</i>	Baboon	Renal lymphoma	13 years	Male	Secondary	SNPRC	Multicentric *
<i>Papio</i>	<i>Papio spp.</i>	Baboon	Renal papillary adenoma	27 years	Female	No	SNPRC	
<i>Papio</i>	<i>Papio spp.</i>	Baboon	Renal adenoma	17 years	Female	No	SNPRC	
<i>Papio</i>	<i>Papio spp.</i>	Baboon	Renal lymphoma	5 years	Male	Secondary	SNPRC	Multicentric *
<i>Papio</i>	<i>Papio spp.</i>	Baboon	Renal adenoma	Unk	Unk	No	[34]	
<i>Papio</i>	<i>Papio spp.</i>	Baboon	Renal adenoma	Unk	Unk	No	[34]	
<i>Papio</i>	<i>Papio spp.</i>	Baboon	Renal adenoma	40 years	Unk	No	[4]	
<i>Papio</i>	<i>Papio spp.</i>	Baboon	Renal adenoma	45 years	Unk	No	[4]	
<i>Papio</i>	<i>Papio spp.</i>	Baboon	Renal adenoma	38 years	Unk	No	[4]	
<i>Presbytis</i>	<i>Presbytis cristatus</i>	Silvery lutung	Renal carcinoma	13 years	Female	No	[14]	
<i>Saguinus</i>	<i>Saguinus oedipus</i>	Cotton-top tamarin	Renal papillary adenoma	Adult	Female	No	[36]	
<i>Saguinus</i>	<i>Saguinus oedipus</i>	Cotton-top tamarin	Nephroblastoma	Adult	Male	No	[14]	

* Unk = Unknown

Multicentric = tissue of origin is not certain; tumor was found in multiple organs