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# Renal Failure in a Female Muskrat

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Renal failure syndrome in wild mammals is infrequently reported. Muskrat (*Ondatra zibethicus*) is a medium-sized rodent known to carry many diseases but rarely exhibiting renal failure. A six-month old female muskrat was submitted to our laboratory for pathological diagnosis, and necropsy revealed severe renal damage with sand-like lithiasis in the ureter, renal calculi, and hydronephrosis. All major organs, including the cerebrum, also showed systemic hemorrhage and calcification which may have been due to uremia induced by renal failure. Histopathologically, necrosis and microcalcification were detected in the renal cortex and the medulla, especially in the proximal convoluted tubules and collecting ducts of the kidney. Significant hyalinization of the glomeruli was also observed, and this suggested chronic nephritis. These findings would support mycotoxic effects, particularly on the kidney. Moreover, infiltration of neutrophils and mononuclear cells was observed in the lung and of plasma cells in the spleen. The definitive cause of the toxic effects in this case of muskrat renal failure could be attributed to contaminated food.

**Key words** : Calcification, muskrat, nephropathy, tubular necrosis, uremia

## Introduction

The kidney is an important organ which performs a number of crucial functions in the body including filtering the blood; remove the waste materials from food and toxic substances; control the fluid balance in the body [6, 12]. Renal failure is the end stage of chronic kidney disease characterized by severe decline in renal functions [2].

Muskrat (*Ondatra zibethicus*) is the only semi-aquatic rodent that belongs to the tribe Ondatrini and it is found in different parts of the world [16, 17]. Muskrats inhabit lakes, ponds, streams, rivers and marshes. Their population is estimated to be 40 animals per hectare [5]. They have body characteristics that enable them to survive in aquatic environments such as lips that close behind incisors, hind feet that are partially webbed, besides their ability to stay under water up to 20 minutes. They feed on aquatic vegetation (cattails and horsetails) and occasionally mussels, turtles, mice, birds, frogs and fish [4, 10]. They are skilled architects that they use vegetations to build their houses above water level, while the entrance via underwater tunnels [5]. However, renal failure syndrome rarely reported in muskrat. Here, we describe the histopathological observations of major body organs in muskrat.

## Materials and Methods

Female muskrat died at the age of 6 months was brought to our laboratory at department of Pathology, College of Veterinary Medicine, Kyungpook National University for necropsy. Animal was died suddenly without prior clinical signs. Muskrat was fed on Alfalfa, hay and commercial rabbit diet. Animal was housed in appropriate conditions with water temperature of 15~16℃ and a shade temperature of 20℃. For microscopic examination, the tissue specimens were fixed in 10% neutral buffered formalin and embedded in paraffin. The tissue samples were sections at 5-$\mu$m slices and then sections were routinely processed with a graded ethanol series and toluene. Finally, the sections stained with hematoxylin and eosin (H&E) [8, 11].

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## Results and Discussion

At necropsy, muskrat showed sand like Urolithiasis in the ureter, and kidneys; hydronephrosis was also evident (Fig. 1, Fig. 2). Systemic hemorrhage and calcification of all organs were observed.

Detailed histopathology of female muskrat showed severe congestion and hemorrhage of the lung accompanied with edema that occupying alveoli. Focal infiltration of neutrophils and diffuse infiltration of mononuclear cells were observed in interstitial tissue and inside alveoli (Fig. 3A). Severe hemorrhage and depletion of lymphoid follicles were evident in the spleen. Diffuse infiltration of plasma cells was also observed especially in sub-capsular region in the spleen (Fig. 3B). Both kidneys showed diffuse microcalcification in the cortex and medulla with tubular degeneration and inflammation remarkably, Calcification was mostly evident in proximal convoluted tubules and collecting ducts. Peri-glomerular and inter-tubular hyalinization were remarkable and it was suggestive for chronic nephritis (Fig. 3C). The left ureter revealed desquamation of the lining epithelium with calcium salts that were detected in the lumen (Fig. 3D).

In the current case we are describing the pathology of renal failure in a muskrat for the first time, to the author's best knowledge. Various nephrotoxic drugs are identified including cancer therapeutics, drugs of abuse, antibiotics, and radiocontrast agents [13]. Several Pollutants also found in environment and affect the kidney such as cadmium, mercury, arsenic, lead, trichloroethylene, bromate, brominated-flame retardants, diglycolic acid, and ethylene glycol [18]. Aristolochic acid and mycotoxins such as ochratoxin, fumonisin B1 and citrinin are natural toxins that target kidneys

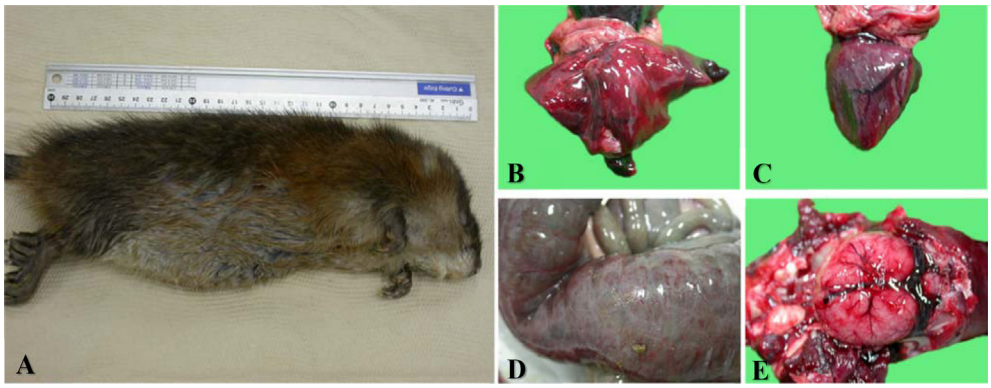


Fig. 1. Gross pictures representing pathological changes in various body organs. (A) Picture of a female musk rat. (B) Severe hemorrhage in all lobes of the lung. (C) Diffuse hemorrhage and a little edema of the heart. (D) Serosal hemorrhage in the small intestine. They were also filled with brown to black contents with mucosal ulceration. (E) Severe hemorrhage and congestion of the meninges.

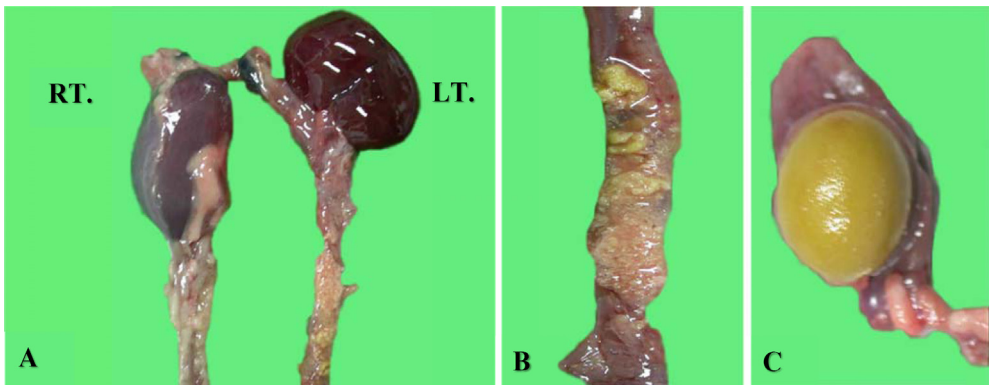


Fig. 2. Gross pictures representing pathological changes in kidneys, ureter and urinary bladder. (A) Moderate congestion of both kidneys. The left kidney also showed hydronephrosis and renal calculi on cut section. (B) The ureter contained sand-like green to yellowish lithiasis. (C) Hemorrhage on the serosal and mucosal membrane of urinary bladder with round and yellowish urolithiasis 2-2.5 cm in a diameter. RT, Right Kidney. LT, Left Kidney.

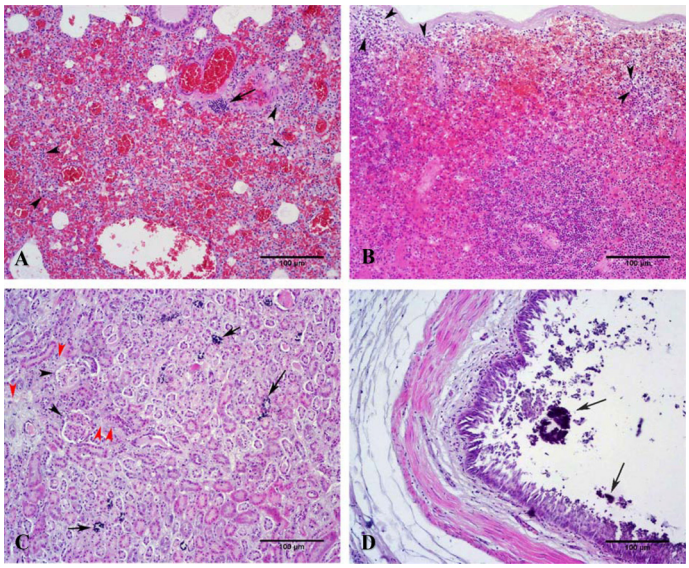


Fig. 3. Histopathological findings of lung, spleen, kidney and ureter in died muskrat. (A) Severe hemorrhage and congestion with interstitial pneumoniae accompanying inflammatory cells infiltrates in the lung. Focal infiltrate of neutrophils (arrow), infiltration of mononuclear cells in interstitial tissue (arrow heads). (B) Severe hemorrhage and depletion of lymphocytes in the white pulp with infiltration of a large number of plasma cells (arrow heads). (C) Both kidneys showed diffuse microcalcification (arrows) in the cortex and medulla with tubular degeneration. Hyalinization of glomeruli (black arrow head) and interstitial tissue (red arrow heads) were suggestive for chronic inflammation. (D) The left ureter revealed desquamation of the lining epithelium with necrosis and microcalcification. Hematoxylin and eosin (H&E) staining. All scale bar = 100 μm.

[1, 9].

In our case, the histopathological observations were supportive of a chronic toxicity and mainly on convoluted tubules in kidney. Moreover, the calculi, the systemic hemorrhages and calcification in several organs were compatible with uremia. The cause of renal failure in our case did not seem to be toxification by aflatoxins and fumonisin, since specific lesions in liver that are caused by theses toxins were not detected [3, 7, 14, 15]. Therefore, there is a high possibility that the renal failure in this case may have been produced by other nephrotoxins in the foodstuffs. However, we couldn't determine the exact toxins and fungi for this case. This report presents evidences that support the mycotoxic hypothesis of diet-induced nephropathy [8]. Here, we have described a rare case report of renal failure with calcification in a muskrat displaying nephrotoxicity most likely by foodstuffs.

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## The Conflict of Interest Statement

The authors declare that they have no conflicts of interest with the contents of this article.

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## 초록 : 암컷 사향쥐(*Ondatra zibethicus*)의 신부전

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야생 포유류의 신부전 증후군은 거의 보고가 없다. Muskrat (*Ondatra zibethicus*)는 중간 크기의 설치류이며 많은 질병을 가지고 있으나, 신부전 증후군은 보고된 바가 없으며, 본 케이스는 병리학적 진단을 위해 6개월령 암컷 사향쥐의 다른 임상증후군 없는 상태로 부검을 실시하였다. 요관, 신장결석과 수진증을 관찰하였고, 결석에 의한 심각한 신장 손상과, 뇌 손상을 포함한 전신 출혈과 석회화가 관찰되었고, 이는 신장 손상으로 인한 요로결석과 장기 손상에 기인한 것이다. 괴사 및 미세석회화는 신장 피질 및 수질에서, 특히 근위 곡 세뇨관 및 신장의 수집관에서 검출되었다. 사구체의 초자양변성이 크게 관찰되었으며 이는 만성 신염을 나타내며. 이러한 소견은 특히 신장에 대한 진균성 독성 효과를 나타내는 것으로 사료된다. 또한, 폐에서 호중구 및 단핵 세포의 침윤이 관찰되었고, 비장에서도 만성 염증세포인 형질세포의 침윤이 관찰되었다. 본 소견에서는 사향쥐 신부전에 따른 사인은 오염된 사료섭취로 의심되는 것으로 판단된다.