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UROGENITAL SINUS CALCULI IN A SAND TIGER SHARK (*ODONTASPIS TAURUS*)[1]

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ABSTRACT: Two calculi were found in the urogenital sinus of a 70 kg female sand tiger shark (*Odontaspis taurus*). The calculi were white in color, rough surfaced, and spherical in shape. Crystallographic examination revealed that they were composed of magnesium ammonium phosphate hexahydrate (80% struvite) and calcium phosphate (15% carbonate apatite). Approximately 5% of the stone matrix consisted of blood and protein and a distinct bacterial nidus was not present microscopically.
Key words: Urogenital calculi, struvite, sand tiger shark, *Odontaspis taurus*, case report.

INTRODUCTION

Urinary system calculi are a fairly common finding in many species including the domesticated dog and cat (Brody, 1955; Goulden, 1968; Bohonowych et al., 1978). The term calculus is derived from the Latin for "pebble" and is defined as an abnormal concretion occurring within the body. Those found in the urinary system are often referred to as uroliths (Greek: *lithos* = stone).

Uroliths are named based on their location, shape and mineral composition. They usually consist of a mixture of different minerals with one type predominating. The etiology of the formation of urinary calculi is often controversial (Brody, 1955; Goulden, 1968; Brown et al., 1977; Bohonowych et al., 1978). However, they are usually thought of as a secondary occurrence related to an underlying abnormality or as a result of a combination of predisposing factors such as an improper diet, urinary tract infection, metabolic imbalance, abnormal urine pH, genetic predisposition, etc. (Brody, 1955; Goulden, 1968; Weaver, 1975; Brown et al., 1977; Bohonowych et al., 1978).

Uroliths are reported in many vertebrate species (Brody, 1955; Goulden, 1968; Weaver, 1975; Bohonowych et al., 1978). However, they have not been commonly found in members of the Chondrichthyes. This study describes a case of urogenital sinus calculi in a captive sand tiger shark (*Odontaspis taurus* = *Eugomphodus taurus*).

MATERIALS AND METHODS

An adult 70 kg female sand tiger shark (*Odontaspis taurus*) was maintained on exhibit at Sea World of Florida. The shark's habitat was a 2.3×10^6 liter pool measuring $38 \times 18 \times 5$ m. The water was artificial seawater which is highly filtered and ozonated. The animal was fed approximately every 2–3 days with a diet consisting of a variety of fresh frozen fish, including mackerel, herring, and blue runner, but was noted to have a less than average appetite in comparison to others of the same species. After 3.5 yr of stability, the appetite of the animal decreased further and despite medical therapy she expired. The animal was subjected to routine necropsy.

Crystallographic examination of calculi was by the method of Otnes and Montgomery (1980) and was performed in a private laboratory (Louis C. Herring Co. Laboratory, 111 South Orange Ave., Orlando, Florida 32806, USA).

RESULTS AND DISCUSSION

Necropsy findings did not reveal a particular cause of death although numerous chronic abdominal adhesions were present between the major organs. While examining the urogenital system, the urogenital sinus was incised and was found to contain two small, white-yellow, rough-surfaced calculi which totalled 9.0 g.

[1] Sea World contribution number SW8613-F.

Approximately 80% of the calculi consisted of friable masses of cryptocrystalline to fine orthorhombic crystals of magnesium ammonium phosphate hexahydrate (struvite, $MgNH_4PO_4 \cdot 6H_2O$) while 15% was a random mixing of microcrystalline calcium phosphate (carbonate form, $Ca_{10}(PO_4\ CO_3OH)_6(OH)_2$). Blood and protein matrices (5%) were demonstrated, but a distinct bacterial nidus was not microscopically apparent. Microcrystalline aggregates have been noted in the urine of some teleosts such as the sculpin ($MgHPO_4 \cdot 3H_2O$; Pitts, 1934) and flounder ($CaHPO_4 \cdot 2H_2O$; Hickman, 1968).

Shark renal anatomy and physiology differs from that of terrestrial mammals where most of the investigative research on uroliths has been performed. The unique differences deserve some mention regarding their potential relationship to the etiology of the stone formation. The shark's strap-like mesonephric kidney is situated retroperitoneally along the dorsal body wall. While the general architecture of the shark nephron is similar to mammals, the rate of glomerular filtration averages about 4.0 ml/hr/kg and is thought to be intermittent in function (Hickman and Trump, 1969). The normal pH of shark urine is acidic and the reabsorption of water from the filtrate is closely linked to the active reabsorption of urea (Smith, 1931a, b; Hickman and Trump, 1969).

As a result of existing in a seawater environment (Table 1), marine elasmobranchs tend to gain salts from their water and appear to regulate different ions independently (Smith, 1931a, b, c; Burger, 1967; Hickman and Trump, 1969). Sodium, chloride, potassium and calcium are reabsorbed from the filtrate with sodium and chloride being actively excreted by the rectal gland (Burger and Hess, 1960; Burger, 1962). Magnesium, sulfate and phosphate are actively secreted into the filtrate.

It is not known whether increases in certain ions, such as magnesium and sulfate in the urine of sharks, is a result of changes in gill permeability or the oral ingestion of seawater. In addition, some elements such as phosphate and chloride have been shown to increase during certain abnormal metabolic states such as starvation (Hartman et al., 1944; Martini, 1974).

At the present time it would be difficult to hypothesize the etiology of the calculi in this shark. Numerous factors may be involved including a potential difference in the element composition of artificial seawater, foods with nutritional imbalances, changes in gill permeability, differences in renal secretion or absorption of urinary elements (resulting in a supersaturation of stone components), urinary tract infection,

TABLE 1. Elemental components of natural seawater, artificial seawater and urine from a dogfish shark *Squalus acanthias*.

Element	NSW[a]	ASW[b]	Urine[c]
Sodium	10,500[d]	10,100	5,520
Potassium	380	355	79
Magnesium	1,350	1,275	972
Lithium	0.18	0.38	
Calcium	400	388	120
Strontium	13.3	16	
Manganese	0.002	0.001	
Copper	0.003	0.007	
Aluminum	0.01	<0.01	
Zinc	0.01	0.014	
Iron	0.01	0.012	
Nickle	0.0054	0.017	
Bromide	65		
Iodine	0.06	<0.01	
Vanadium	<0.01	<0.01	
Molybdenum	0.01	<0.01	
Cobalt	<0.001	<0.001	
Chloride	19,000	15,500	8,520
Sulfate	2,650	2,150	6,720
Carbonate	28	0	
Bicarbonate	139.7	163	
Phosphate	0.07	30	3,069
pH	8.3	8.2	5.8

[a] Natural seawater.
[b] Artificial seawater.
[c] Urine from a dogfish shark (*Squalus acanthias*) shown for comparison (Burger, 1967).
[d] ppm.

urine pH abnormalities, or other generalized disease states.

An analysis of the artificial seawater in Table 1 shows that as far as the elements comprising the stone are concerned there are few differences from natural seawater. One difference which may be significant concerns the biological processes which occur in a closed environment. Certain compounds, phosphate in particular, have a tendency to increase with time and remain considerably elevated in comparison to levels in the natural marine environment. A comparison of seawater components with the urine of the dogfish shark shows the relative amounts of major elements in both fluids (Table 1).

The exact dietary needs of elasmobranchs are still under study. However, present diets utilizing the same water quality and recirculated biological systems have not resulted in urinary system calculi in other animals examined.

The potential involvement of a disease state in calculi formation is a major consideration. This may include inherited, congenital, developmental, toxic, metabolic and/or infectious causes. Some of the above etiologies may be difficult to define because a broad based data bank of normal biologic parameters is not well established for many shark species.

The relationship of struvite stone formation to the presence of infection appears to differ even between terrestrial species. Struvite stones in the dog are usually associated with a urease-producing infection (Goulden, 1968; Weaver, 1975; Brown et al., 1977). In the domestic cat, often the struvite stones are sterile (Bohonowych et al., 1978). The absence of a visible bacterial nidus in the shark calculi may indicate that an infection is not involved. Unfortunately, as a result of contamination during the necropsy, urinalysis and urine bacteriology were not performed. Future examinations of the urogenital system should include careful palpation of the urinary system and needle aspiration of urine for analysis.

Shark "medicine" is still in its early stages. Nevertheless, it is possible to apply good principles of medicine to the shark, which will increase our knowledge of important disease states. This includes periodic handling and establishment of normal parameters for each individual.

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