CHRONIC SINUSITIS AND OSTEONECROSIS IN DESERT BIGHORN SHEEP (*OVIS CANADENSIS NELSONI*)

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ABSTRACT

Chronic sinusitis is a major mortality factor in desert bighorn sheep and may have brought about the decimation of some populations and restricted expansion of others. The incidence of sinusitis in a captive population of desert bighorn at Zion National Park, Springdale, Utah, is 41 per cent and the disease is terminal. Sheep with sinusitis exhibit varying degrees of necrosis of the skull ranging from porous bone to areas of extensive lysis of the frontal bone, horn core, and sheath. Sheep with sinusitis undergo extensive debilitation, often to the extent of losing half their body weight. Also associated with the disease are open lesions on the forehead, which may become parasitized by fly maggots. Osteonecrosis of the orbits may result in blindness. Central nervous disorders have been related to abscessation of the brain resulting from osteolysis of the brain case. Sheep with sinusitis in its more advanced stages will become solitary, and ewes may not be capable of rearing their lambs. The skeletal results of sinusitis in the desert bighorn at the Park resemble descriptions of necrotic skulls of desert bighorns found in Arizona and Nevada. The etiological agent may be the larvae of the sheep nasal bot (*Oestrus ovis*), with the sinusitis

being initiated by necrotic larvae and subsequent invading bacteria. Corynebacteria have been the most common microbes isolated from the pus-like exudates. Trephining the frontal sinus and adjacent horn core appears to be the only effective treatment.

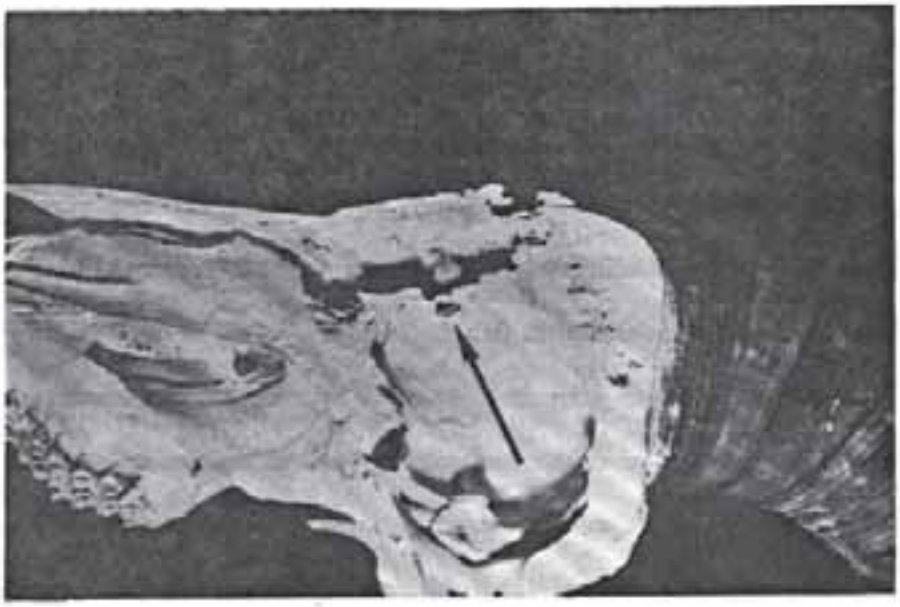
INTRODUCTION

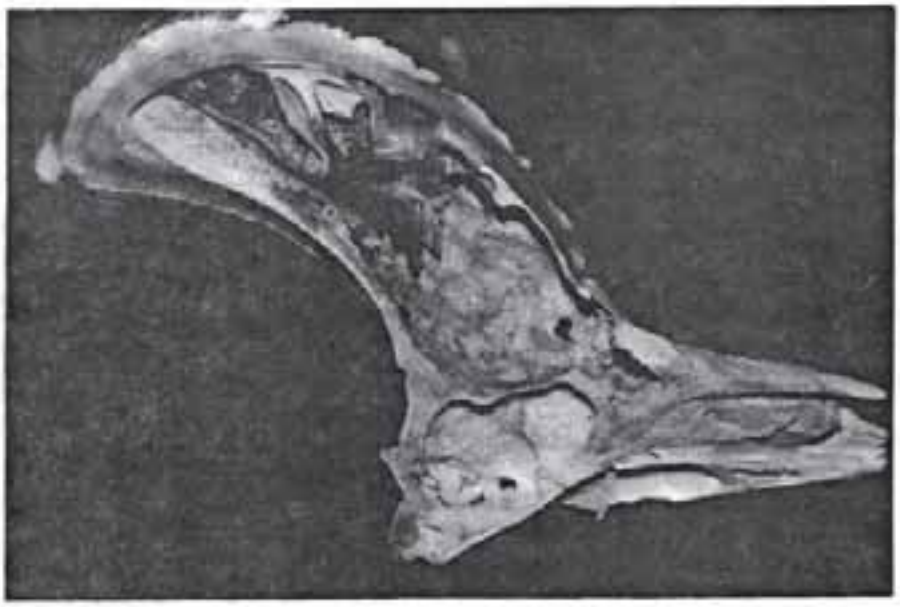
Osteonecrosis and skeletal anomalies have been reported in desert bighorn (Ovis canadensi nelsoni) skulls from Arizona and Nevada (Hansen, 1961; Arizona Game and Fish Department, 1963; Allred and Bradley, 1965). The skulls exhibited varying degrees of necrosis, ranging from spongy, porous bone to areas of extensive lysis in the frontal bone, horn sheath, and horn core. Ram skulls often displayed differential basal circumferences of horns, in association with concomitant changes of the palatal suture and occipital condyles. Skeletal anomalies in ewe skulls were more variable than those in rams. The ewes evidenced bone damage over a wider area, often involving the lacrimal bone, orbital bone, infraorbital foramen and tooth archade. Ewe skulls seldom displayed the large lesions or cavities in the frontal bone found in ram skulls. According to Allred and Bradley (1965), 23 per cent of the ewe skulls and 3 per cent of the ram skulls they examined from the Nevada Desert Game Range skull collection exhibited necrosis of the frontal bone, and 75 and 49 per cent, respectively, displayed necrosis of a lesser extent involving the tooth archade infraorbital foramen, orbital, and lacrimal bone. Although the etiological agent was not identified, the extent of skeletal damage (particularly the anomalies of the frontal bone) was considered as a causing the demise of the sheep.

RESULTS

Reports about the Arizona bighorn are scarce, mainly coming from hunters and taxidermists. In 1962, 7 per cent of the rams killed during the hunting season exhibited osteolysis of the frontal bone, horn core, and sheath (Arizona Game and Fish, 1963). The necrosis was primarily ascribed to mechanical injury followed by secondary invasion of bacteria. During 1977, a ewe was observed circling and was then diagnosed as having a central nervous system disorder. Subsequent post-mortem findings indicated that the ewe had died of two brain abscesses that entered the brain case from a necrotic left horn (Hospital Admission Record, 1977). Corynebacterium pyogenes was isolated from the brain abscesses.

Sinusitis that leads to osteonecrosis, as observed in the Arizona and Nevada sheep, was first observed in Utah in a captive population of desert bighorn at Zion National Park. The sheep (3 rams, 5 ewes, and 4 lambs) had originally come from River Mountains and Corn Creek in Nevada and been relocated into an 80-acre enclosure in Zion National Park, Springdale, Utah, in 1973. In 1975, a condition that was later diagnosed as chronic sinusitis was observed in a dominant ram. The ram had undergone a progressive debilitation from 1974 to the time of his death in 1975, when he weighed only 100 lbs. Post-mortem examination revealed osteolysis and abscessation of the nasal and frontal region of the skull, thinning of bone of the upper brain case, lysis of the brain case, extreme necrosis of the orbitals, and total destruction of the trabeculae within the horn cores (Figures 1 and 2). Examination of





Figures 1 and 2. Chronic sinusitis has resulted in extreme osteolysis in the frontal region of the skull, thinning of upper brain case, lysis of brain case (arrow) and total destruction of the trabeculae within the horn core.

skulls from 2 other rams and 2 ewes that also died within the enclosure indicated that sinusitis had contributed to their death. Various degrees of osteonecrosis and porosity of the bone were observed, with the most pronounced bone anomalies being seen within the horn cores. Positive verification of the disease in three of the skulls required sagital sections of the frontal sinus and horn core.

Sinusitis has recently been monitored in four living desert bighorn at Zion National Park. Prior to capture, these sheep had exhibited varying degrees of physical and behavioral changes. The characteristic progressive debilitation extended over 7-12 months, and in some cases ended in death. Some of the sheep lost nearly half their body weight before dying. Often drainage at the frontal region of the skull was observed. Developing lesions could be recognized as small matted regions of hair at the base of the horns. One sheep went blind from osteolysis of the orbit and subsequent infection of the eye. Open lesions also became sites for maggot infestations. Often the infected sheep sought seclusion to avoid harrassment by other sheep. A diseased ewe with a lamb was not able to rear her offspring because of an insufficient milk supply and a decrease in mothering ability. Once a sheep evidenced the disease, unless it was treated, the process appeared to be inexorably terminal. The incidence of sinusitis in the Zion sheep 1 year or older is 41 per cent. Organisms isolated from sheep having the sinusitis have mainly been corynebacteria, streptococci and proteus. No microbial agents other than bacteria have been isolated.

Eleven of the 13 sheep remaining in the Zion enclosure in 1978 were recently captured and examined for signs of sinusitis. Prior to capture, a 3.5 year old ewe was observed (with a spotting scope) to have an unusual tuft of hair on the forehead. Upon close examination, the tufted hair region was seen to be the result of an open and draining lesion involving the frontal sinus. The basal circumference of the horn on the infected side was larger than that of the other. The ewe was the only sheep that displayed noticeable symptoms of sinusitis.

One reason for capturing the sheep was to establish a method of early diagnosis. Besides physically examining each animal, blood samples were taken and checked for a possible marker for the disease. Comparisons, however, could only be made between the one ewe that had been identified as having sinusitis and those that appeared normal. Some of the sheep considered normal may have had an early stage of sinusitis.

Blood cell differential counts were not indicative of sinusitis (Table 1). The blood cell types and related counts of the ewe identified as having sinusitis were within the range of the sheep sampled. The total WBC counts, however, were second to the highest. The sheep with the highest count was not positive for the disease upon physical examination.

Serum components are often used as a measure to determine an animal's physical condition. Evaluation of the serum samples from the desert bighorn indicated that on the average, the blood components of ewe #2 varied from the mean (Table 2). These differences, however, could not be correlated with the differential blood cell counts. The small numbers

Table 1. White blood cell counts on desert bighorn sheep from Zion National Park, Springdale, Utah.

Sheep ID number	WBC Count	Basophils	Eosinophils	Bands	Segs.	Lymph.	Mono.
1	10,250	0	1	2	46	45	6
2*	12,250	0	0	5	53	39	3
3	9,450	0	2	10	37	38	13
4	11,900	0	0	4	60	29	7
5	10,350	0	0	5	64	25	6
6	9,750	0	4	1	73	21	1
7	13,700	0	2	2	75	18	3
8	9,400	0	1	3	79	15	2
9	9,650	0	0	4	79	12	5
10	7,850	0	0	2	63	32	3
11	10,950	0	7	1	63	23	4

* positive for sinusitis

Table 2. Serum analysis of desert bighorn sheep from Zion National Park, Springdale, Utah.

ID number	Calcium (mg/100ml)	Inorganic phosphorus (mg/100ml)	Glucose (mg/100ml)	Bun (mg/100ml)	Uric acid (mg/100ml)	Cholesterol (mg/100ml)	Total protein (gr/100ml)	Albumin (gr/100ml)	Total Bilirubin (mg/100ml)	Alkaline phosphatase (mU/100ml)	LDH (mU/100ml)	SGOT (mU/100ml)	SGPT (mU/100ml)	Creatinine (mg/100ml)
1	10.4	7.9	185	24	0.7	70	6.6	3.9	0.6	>550	760	192	41	2.1
2*	9.6	6.4	185	20	0.6	55	7.8	4.0	0.5	205	570	190	31	1.9
3	10.4	6.0	155	26	0.6	60	6.0	3.9	0.4	>550	1030	>500	54	1.6
4	10.6	10.7	286	21	1.0	60	6.4	3.8	0.5	>550	1330	390	33	2.0
5	10.1	5.6	220	12	0.5	50	6.0	3.0	0.4	>550	880	260	33	1.6
6	9.4	4.0	240	20	0.6	50	7.2	3.2	0.4	135	550	200	27	1.5
7	9.8	3.4	220	12	0.6	50	6.2	2.9	0.4	>550	760	180	22	2.0
8	10.5	5.5	260	23	0.7	60	6.8	4.0	0.7	140	720	410	27	2.0
9	10.2	3.2	240	24	0.7	75			0.7	160	700	235	33	2.1
10	9.6	3.5	245	28	0.7	80	7.2	3.9	1.5	162	745	220	23	2.0
11	9.5	4.0	250	23	0.6	60	5.8	3.7	3.7	>550	1050	355	36	1.6
	10.01 ±.1311	5.47 ±.6880	226.0 ±11.5049	21.1818 ±1.5481	0.66 ±.0388	60.91 ±3.0761	6.6 ±.2044	3.63 ±.1350	.63 ±.0973	372.90 ±61.5715	826.82 ±69.5971	284.73 ±33.1729	32.73 ±2.7139	1.75 ±.1090

*Identified as having sinusitis
BUN - Blood urea nitrogen
LDH - Lactic acid dehydrogenase
SGOT - Serum glutamine oxalacetic transaminase
SGPT - Serum glutamine phosphatase transaminase

of sheep sampled and our inability to identify sinusitis except in advanced cases have made it difficult to evaluate whether blood components can be used as a marker for early diagnostic screening. Erratic rectal temperature readings, respiration rates and heart beat patterns were attributed to excitement during handling.

It has been noted, however, that sheep with sinusitis often have slightly higher temperatures in their areas of infection. This heat differential may prove to be diagnostic. Efforts are being made, therefore, to determine if infra-red sensoring can be used to screen animals and to determine location and extent of infection

The etiological agent that causes sinusitis in desert bighorn sheep has not been established. Necrosis of the skulls of the Arizona sheep was partially ascribed to mechanical damage, particularly bone anomalies associated with the horn. Causes of the necrosis in other areas of the skull were unexplainable. A post-mortem examination of 1 of 3 Zion Desert bighorns that died from chronic sinusitis revealed necrotic bot fly larvae in the pus-like sinal exudate. Although little is known about the effects bot fly larvae may have on wild sheep, their etiology in domestic sheep has been amply described. The sheep bot fly deposits living young in the nostrils of sheep. The larvae often migrate into the frontal sinus where they reach maturity before returning to the nostrils, from whence they are sneezed out and drop to the ground. The larvae set up an irritation that results in more than average mucus coming from the nose, but this mucus only becomes thickened and discolored after secondary invasions of the mucosa by bacteria (Krull, 1969).

Cobbett and Mitchell (1941) reported that such bot fly induced inflammation of the mucosa is always associated with necrotic larvae and secondary bacterial infections. Domestic sheep parasitized by nasal bot larvae rarely die, and then only if they cannot expel the copious mucus. Death comes from suffocation or from abscesses in the deeper recesses of the frontal sinus. The heaviest larval infections have been seen only in horned sheep which have larger and more spacious sinuses.

The anatomy of the skull of the desert bighorn, which serves so successfully as a shield in their head to head duels, may be contributing to their susceptibility to chronic sinusitis, particularly if the etiological agent is the larvae of the bot fly. The brain of the bighorn is overlayed by two separate stratifications of bone that have cross connections of bone. The double roof of bone begins about 5-6 cm. anteriorally from the brain and extends to the occiput. The highly pneumated or chambered horn cores are continuous with the frontal sinus. In comparison, the frontal sinus in domestic sheep is much smaller. An infection in the posterior or lateral regions of the brain in the desert bighorn has no outlet and would be extremely difficult to drain naturally. Once established, the pervasive infection spreads throughout the horn core, frontal and maxillary sinuses, causing osteolysis of the frontal and lacrimal bones, orbitals brain case, horn core, and sheath.

CONCLUSIONS

Chronic sinusitis in bighorn sheep appears to be terminal unless otherwise treated. Treatment of any merit at the present time is limited

to sheep that are captive or are available to capture. No systemic or oral antibiotics can effectively treat such an infection. The animal must be trephined. The infected sinus must then be flushed with antibacterial and antiseptic agents in both directions on a daily basis for one to three weeks depending upon the extent of the infection. Trephining involves boring one ½" hole through the frontal bone and another midway or farther up on the horn (Figure 3). The infection cannot be properly treated without both holes. To keep the opening in the frontal bone functional, it is necessary to insert a ¼" catheter for drainage. The catheter can be sutured to the forehead and alongside the nose. Sheep can be intensively treated for several weeks in isolation. However, they must be given antibiotics to prevent pneumonia.

The desert bighorns are faced with numerous mortality factors that challenge their survival. Sinusitus is one such challenge that undoubtedly has taken a heavy toll and will continue to do so.

This brief report cannot present the whole story, but it does describe the serious implications the disease has for the desert bighorn. Sinusitis in the desert bighorn at Zion National Park has taken its toll from all age groups one year or older, and at a rate of 41 per cent. Ewes may be particularly vulnerable. For the lambs, there is no known tally. Unfortunately, too little is known about the etiology of the disease to prescribe appropriate management quidelines. All concerned with the survival of the desert bighorn will have to cooperate if the remaining questions are to be answered.

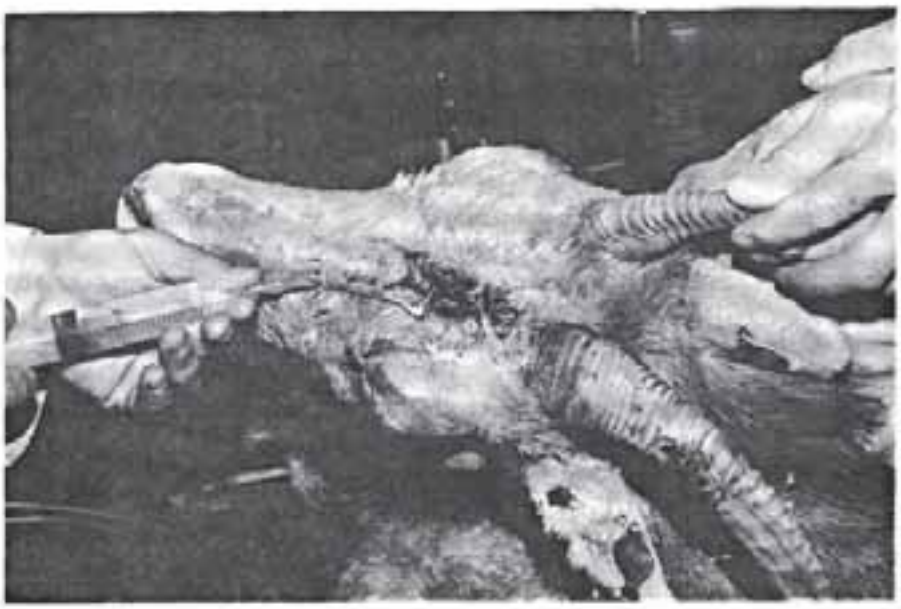


Figure 3. Trephining the frontal sinus and horn core is the only known effective treatment for chronic sinusitis.

ACKNOWLEDGEMENTS

The authors express their appreciation to Drs. J.W. Call and R.A. Smart for their assistance in post-mortem examinations and diagnostic evaluations. The authors are also grateful to the Arizona Game and Fish Department for assistance in providing information on sinusitis in the desert bighorn of Arizona and to the Utah State Division of Wildlife Resources for their assistance in capturing sheep at Zion National Park.

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