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Surgical Technique for Ambulatory Management of Airsacculitis in a Chimpanzee (*Pan troglodytes*)

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***Purpose*: Bacterial infections of the air sac have been reported in many nonhuman primates. Approaches to the management of airsacculitis have included combinations of medical and surgical therapies. These strategies have often required repeated attempts to drain exudate from the affected air sac, as well as necessitating that the animal endure isolation or undergo intensive postoperative care before returning to its social group.**

***Methods*: A stoma was created via deliberate apposition of the air sac lining and skin to allow continuous drainage. Antibiotic therapy based on culture and antimicrobial susceptibility of the air sac contents was administered while the chimpanzee remained in its social group.**

***Results*: We were able to attain complete resolution of the infection after a course of oral antibiotic therapy. The stoma closed gradually over a three-week period, and the chimpanzee has remained free of infection since that time.**

***Conclusion*: Despite the severity of the air sac infection in this chimpanzee, we were able to resolve the infection easily, using a simple surgical technique. This method allowed treatment without interfering with social standing or subjection to repeated anesthetic and treatment episodes. This method could be a simple, useful alternative for managing airsacculitis in nonhuman primates.**

The laryngeal air sac of the chimpanzee consists of a central and two lateral parts. The central portion extends from the hyoid bone craniad to the manubrium of the sternum caudad. The central portion of the air sac communicates with the larynx via the laryngeal ventricles, which lie between the ventricular and vocal folds. The right and left diverticula of the air sac are often dissimilar in size, and there are commonly extensions of the sac into the axillae (Fig. 1) (1).

Investigators have described air sac infections in the owl monkey (2), baboon (3, 4), orangutan (5-10), bonobo (11), and mountain gorilla (12). As has been reported, many of these infections are bacterial and are caused by enteric organisms (2, 4-13). There are also a few reports describing infections in the chimpanzee (10, 11, 14). Many of the air sac infections in those reports were caused by enterobacteria. Other organisms such as β-hemolytic streptococci, *Staphylococcus aureus*, *S. epidermidis*, and *Staphylococcus sp.* also were isolated. In addition, the respiratory tract inhabitants *Haemophilus influenzae* and *Neisseria meningitidis*, as well as the enteric anaerobe *Bacteriodes sp.*, have been isolated from air sac exudates (11, 14).

Bacterial airsacculitis varies from a potentially life-threatening syndrome complicated by aspiration pneumonia, thromboembolism, septicemia, or abortion (2, 5, 9, 13) to a clinically inapparent infection (14). Often, a mild upper respiratory tract infection, with nasal discharge, malodorous breath, or distention of the cervical portion of the air sac, are the only apparent clinical signs of disease (2-4, 6, 7, 9, 12, 14).

Various approaches to management of bacterial airsacculitis have included medical treatment alone (3, 4, 14) or a combination of medical and surgical therapies (3, 4, 6, 8-10, 12, 14). These therapeutic strategies have often required repeated attempts to drain and flush exudate from the affected air sac, thereby necessitating repetitive anesthetic episodes and the associated risk to the animal's health, not to mention the potential for aspiration of air sac exudate during positioning for medical examination. Often the animal must endure isolation from its social group or intensive postoperative care before returning to its customary living arrangement (3, 4, 6, 9, 14).

We describe a surgical technique for the ambulatory management of airsacculitis in a chimpanzee. The technique allowed the chimpanzee to return immediately to its social group without further manipulations, and we were able to attain complete resolution of the infection after a course of oral antibiotic therapy (which was administered while the chimpanzee remained in the group).

Case Report

The chimpanzees are housed in facilities located at The University of Texas M. D. Anderson Cancer Center in Bastrop, Texas. The facilities are approved by the Association for Assessment and Accreditation of Laboratory Animal Care International and maintained in accordance with the United States Government *Principles for the Utilization and Care of Vertebrate Animals Used in Testing, Research, and Training*, the Animal Welfare Act, PHS Policy on the Humane Care and Use of Laboratory Animals and the *Guide for the Care and Use of Laboratory Animals*. All protocols at the institution are reviewed and approved by the Institutional Animal Care and Use Committee.

The chimpanzee described herein was housed with a semi-free-ranging social group in an octagonal, concrete-walled outdoor compound (387 m^2). The earthen-floored compound is planted with grass and contains a complex of climbing structures. The compound is joined via guillotine doors to a central service building containing two indoor dens (1.8 m wide × 5.4 m long × 3.6 m high). The social group consisted of 13 chimpanzees. The group included four males ranging in age from 7 to 32 years and nine females ranging in age from 1 to 34 years.

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Figure 1. Radiographic view of the neck and thorax of a chimpanzee. Contrast material within the air sac demonstrates its anatomic location. *Radiograph courtesy of the Biologic Resources Laboratory slide collection, University of Illinois at Chicago.*

The subject of this report was a 10-year-old, 37-kg, experimentally naive female chimpanzee with a history of scoliosis and colonic hypomotility that were diagnosed when the animal was approximately 2 years of age. This chimpanzee had a low social ranking. It also had been known to engage in coprophagy on a regular basis throughout its lifetime. At the time of this report, it was observed to have distention of the cervical air sac. Other than the swollen air sac and a foul odor to the breath, other clinical signs of disease were not noted, and the animal did not appear to be ill.

The chimpanzee was sedated initially with 180 mg of Telazol (Fort Dodge Animal Health, Fort Dodge, Iowa) administered intramuscularly. Although the chimpanzee was placed in an upright position as soon as it was able to be removed from the enclosure, exudate was noted in the nostrils and in the pharynx, presumably overflowing from the distended air sac. The exudate and the chimpanzee's breath were distinctly malodorous. Results of physical examination, and in particular auscultation and percussion of the thorax, were otherwise normal and regional lymph nodes were not enlarged.

The chimpanzee was maintained in an upright (sitting) position with the neck extended. (Fig. 2). The head was secured by looping gauze behind the canine teeth and tying the gauze to the gurney on which the animal was seated. An attempt was made to aspirate exudate from the distended cervical portion of the air sac using a 16-gauge needle, but the material was too thick and an appreciable amount could not be withdrawn.

The hair over the skin of the most ventral aspect of the distended air sac was shaved and the skin was gently scrubbed and draped for surgery, with care taken not to exert undue pressure that might lead to more exudate overflowing into the pharyngeal area. A vertical skin incision, approximately 5 cm long, was made at the ventral aspect of the distended air sac. The air sac lining then bulged out of the skin incision. Forceps were used to retract the skin while two lengths of 2-0 Dexon II suture (Sherwood Medical, St. Louis, Mo.) were pre-placed through the air sac lining. The sutures were then held by hemostats and used to elevate the air sac lining above the level of the skin (Fig. 3A).

A vertical incision 3.5 to 4 cm long was then made in the air sac lining, taking care to keep the edges elevated to prevent overflow of the exudate into the subcutaneous space. A sample of the exudate was then taken for microbiological culture and antimicrobial susceptibility testing. The exudate was pale green and had a foul odor. The consistency of the material within the air sac was similar to that of toothpaste. An attempt was made at the time to remove the exudate via suction, using a 16-F feeding tube as the tip for the suction tubing; however, the material was too thick to fit through the suction apparatus.

Figure 2. Chimpanzee positioned to prevent overflow of air sac contents into the pharyngeal area. Notice the distended cervical portion of the air sac.

A decision was then made to create a stoma to allow continuous drainage of the air sac. Anesthesia was maintained by administration of 30 mg of Telazol intravenously on three occasions during the surgical procedure. While the edges of the air sac lining were held in an elevated position, the lining was first attached to the skin by placement of a series of interrupted, horizontal mattress sutures around the opening (Fig. 3B), approximately 0.5 cm from the skin edges, using 2-0 Dexon II. The edges of the air sac lining were then sutured to the skin edges, using a simple continuous pattern, again with 2-0 Dexon II (Fig. 3C).

Once the skin and air sac lining were apposed, the exudate was milked out of the air sac. Gross evidence of foreign material was not seen in the exudate. The material was not examined microscopically. Approximately 1 L of purulent exudate was removed in similar manner. The material was milked from the axillary areas of the air sac as well as the cervical portion. After the exudate was removed, the air sac was flushed numerous times with

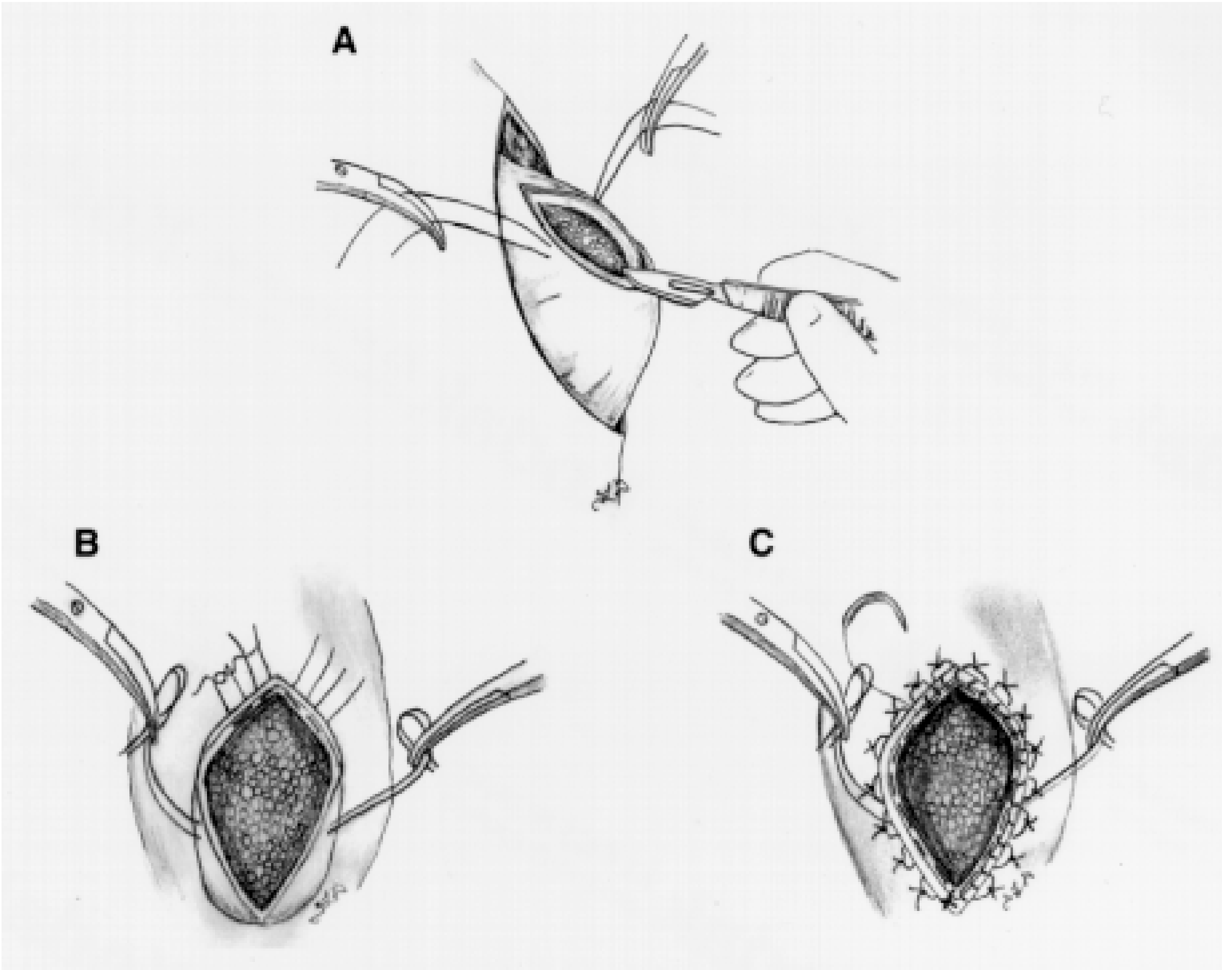

Figure 3. Diagrammatic representation of the surgical procedure. **(A)** Air sac lining being elevated above the level of the skin by pre-placed sutures. **(B)** Air sac lining is first attached to the skin by a series of interrupted horizontal mattress sutures, while the edges of the sac are kept elevated above skin level. **(C)** The skin edges are sutured to the edges of the air sac lining in a simple continuous pattern, creating a stoma.

a 50:50 mixture of hydrogen peroxide and povidone iodine solution until no obvious exudate remained. The chimpanzee was given 1.2 million units of penicillin G benzathine suspension and 75 mg of gentamicin sulfate intramuscularly. Although the possibility of aspiration pneumonia existed, pre-operative radiography of the thorax was not performed because of the chance of the chimpanzee aspirating exudate during positioning. We did not want to risk prolonging the anesthetic episode so postoperative radiography was not done either.

At the time of surgery, the white blood count (WBC) was mildly high at 16,400 cells/μl, with 13,000 segmented neutrophils and 200 band cells/μl. Serum biochemical values were within normal limits. Microbiological analy0sis of the exudate revealed pure culture of β-hemolytic *Escherichia coli* that was susceptible to several cephalosporins.

The chimpanzee was treated with 500 mg of cephalexin (mixed with a fruit-flavored drink) three times daily for seven days. The medication was administered while the animal remained in its social group. It and other members of the group attempted to remove some of the sutures, but most stayed in place as the stoma gradually healed, resulting in complete closure of the wound over a period of three weeks. The animal was sedated and re-examined one month after the surgery. At that time, the cervical and axillary areas of the air sac were massaged while the pharyngeal area was monitored. There was no evidence of exudate overflowing into the pharynx or nostrils. Room air was the only thing that could be expressed from the air sac at the time. Although the chimpanzee was considered to have been at risk for developing aspiration pneumonia, it did not manifest any clinical signs of infection, such as cough, anorexia, lethargy, or dyspnea during the month after surgery. Therefore, we did not believe that radiography was indicated at that time. A follow-up WBC at the time of re-examination was somewhat higher, indicating slight neutrophilia (WBC: 20,900 cells, with 15,200 segmented neutrophils and 0 bands/μl). This particular animal routinely had slightly to moderately high WBC, so WBC of 20,900 cells/μl was not considered unusual. The chimpanzee has remained free of infection for 7 postoperative months.

Discussion

Air sac infections in several species of nonhuman primates have been reported. The clinical course of this syndrome appears to vary among species. In one report involving a gorilla, the infection resolved after lancing of the air sac and administration of a short course of antibiotic therapy (12). In the owl monkey, two syndromes resulting from infection with *Klebsiella pneumoniae* were described. One syndrome was described as acute, non-suppurative airsacculitis with thromboembolism, which resulted in death after a brief episode of illness. The other syndrome, which had a more subacute course, was described as severe, suppurative airsacculitis infiltrating into adjacent tissues. The severity of disease in the owl monkey was proposed to be a function of the infective agent *K. pneumoniae* more than of the location of the infection in the air sac (2). Airsacculitis in baboons has been reported in animals with indwelling catheters that were restrained in special chairs for prolonged periods. Those infections were refractory to conservative therapy and required surgical excision of the entire air sac to eliminate the infection (3, 4).

The orangutan appears to be quite susceptible to bacterial infections of its extensive air sac. Reports of the severity of the condition in this species vary. Sudden death, with the only prior signs being intermittent upper respiratory tract infection, and death without any prior clinical signs of disease have been described (5, 7). Early therapeutic intervention, which entailed lancing of the air sac accompanied by antibiotic therapy, occasionally resulted in complete recovery from airsacculitis (6, 8, 9). Complications of this treatment regimen have also been lethal in some cases (9).

A report of the disease in chimpanzees describes six cases in which the clinical signs of infection included swollen air sacs in four animals, minor upper respiratory tract infections in two animals, and one case that was found incidentally. Only one chimpanzee described in that report had signs of systemic illness prior to treatment. All but one of those cases responded to conservative therapy that involved drainage and flushing of the closed sac along with antibiotic therapy. One case required lancing of the air sac on two occasions to create a permanent draining fistula (14).

The clinical history of the chimpanzee of this report is typical of the uncomplicated cases of suppurative airsacculitis reported in literature (3, 4, 6, 14). Other than the chronically distended air sac and malodorous breath, signs were not apparent in the awake animal. A slightly high WBC with low numbers of bands was the only systemic abnormality observed. Normal to only slightly high WBC have been noted in cases of airsacculitis in several species (3, 4, 11, 12). Culture of the purulent air sac contents revealed infection with an enteric organism. The fact that bacterial airsacculitis has been caused by enteric organisms could support a hypothesis that exposure of the laryngeal ventricles to feces is a potential route of infection (9). The chimpanzee of this report was observed to engage in coprophagy on a regular basis. This habit could have been the cause of the airsacculitis, which was the result of infection with *E. coli*.

The chimpanzee was sedated initially, using a Telinject System dart (Telinject USA, Inc., Saugus, Calif.). Although the chimpanzee was placed in upright position as soon as it was able to be removed from its enclosure, exudate was observed in the nostrils and pharynx. Overflow of exudate from the distended air sac to the pharynx poses a serious risk of aspiration and death. Unfortunately, in our particular situation, the indoor housing area is sufficiently large that we cannot reach the animals without going into the enclosure with them. The only method that we consider safe for our personnel is to wait until the chimpanzee is sufficiently sedated to allow them to enter the enclosure without risk of injury. An alternative method, if this particular chimpanzee were more cooperative, would have been to move it to a small transport cage prior to sedation where it would not have had room to slump over.

Why the chimpanzee described here did not develop a permanent fistula is not clear. Perhaps the fact that the subcutaneous space was protected from contamination by elevation of the air sac lining during surgery and, after surgery by apposition of the air sac and the skin, helps explain the lack of fistula formation. One might expect that the surgical technique itself could have created a permanent stoma if the edges of the air sac and skin had healed together. Gradual removal of the sutures by the affected chimpanzee and other members of the group could help explain eventual closure of the incision. Certainly these manipulations could have introduced new organisms into the air sac or subcutaneous tissues, but there was no way of preventing this tampering even if the affected chimpanzee had been housed alone. Clinicians should be aware of the potential for additional organisms being introduced into the wound and consider re-culturing if exudate or inflammation persist despite appropriate antibiotic therapy.

Although other reports discussed surgical drainage of the affected air sac, they did not describe creation of a stoma via deliberate apposition of the air sac lining and skin. Despite the severity of the air sac infection in this chimpanzee, we were able to resolve the infection easily, using a simple surgical technique along with antibiotic therapy. This method allowed treatment without interfering with social standing in the group or subjecting the animal to repeated anesthetic and treatment episodes. We believe that this approach could be a simple, useful alternative to previously reported methods of managing airsacculitis in nonhuman primates.

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